

# SCIENCE

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FRIDAY, JANUARY 29, 1897.

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## CYCLE IN THE LIFE OF THE INDIVIDUAL (ONTOGENY) AND IN THE EVOLUTION OF ITS OWN GROUP (PHYLOGENY).\*

THE organic cycle, as generally understood both by laymen and scientists, and as usually described in literature, is, as a rule, considered from a physiological rather than structural point of view. The development of the young, and the attainment of the adult or comparatively permanent, stage completes the progressive stages. Old age, accompanied by losses of characteristics and functions and consequent weakening of the body, is retrogressive and brings on second childhood, thus completing the cycle in the ontogeny.

My purpose to-night is to show that the cycle is also represented in the life history of the individual by definite structural changes, and that these have direct correlations with the history of the changes in the forms of the group while evolving in time.†

The fundamental discoveries that are

\* This paper was in large part read as a general summary of the phenomena of cycles, before the American Academy in Boston, but does not assume to be an exhaustive or even complete account of the literature or theoretical views treated of.

† These correlations have been more fully stated in a number of publications by the author, especially 'Genesis of the Arietidae,' Smithsonian Contribution, 673, and Mem. of Mus. of Comp. Zoology, Vol. XVI.; 'Bioplastology and the Related Branches of Scientific Research,' Proc. Bost. Soc. Nat. Hist., XXVI.; and 'Phylogeny of an Acquired Characteristic,' Proc. Am. Phil. Soc., XXXII., No. 143.

more than any other directly useful in the study of the phenomena of the cycle, both in ontogeny and phylogeny, may be briefly noticed as follows:

The opinion that the higher animals are complex, colonial aggregates of cells, which in structure are equivalents to the lowest and minutest adult forms of the animal kingdom, the unicellular bodies of Protozoa, has been steadily gaining in probability since it was first announced by Oken in 1805, in 'Die Zeugung,' Frankfurt bei Wesche, 8vo. This work we have not yet seen, but in the first edition of the *Naturphilosophie*, Jena, 1809, II., XII. Buch, *Zoogenie*, he describes protoplasm as 'Punktsubstanz' and as giving rise to the 'Blasenform or Zellform' in both animals and plants. Oken considered the lower animals 'Polypen, Medusen, Beroen, kurz alle Gallertthiere' to be composed of Punktsubstanz.' The nerves, the cartilage, bones of higher animals, were considered as modifications of this form of 'protoplasm,' but the skin and fleshy parts, including the viscera, were described as cellular, 'dem Fleisch liegt die Bläschenform zu Grunde;' again on p. 30, 'die Eingeweide welche am meisten aus Zellengewebe bestehen.' Oken in XII., VIII. Buch, treats of the subject we are more immediately interested in and writes as follows: "Pflanzen and Thiere können nur Metamorphosen von Infusorien sein," "im kleinsten sind sie nur infusoriale Bläschen die durch verschiedene Combinationen sich verschieden gestalten and zu höheren Organismen aufwachsen," and also adds on p. 29, in anticipation of one of the points advanced by the author in his 'Larval Theory of the Origin of Cellular Tissues,'\* 'auch besteht der Samen aller Thiere aus Infusorien.'

This author directly compares his cystic or intestinal animals, Infusoria, with ova,

\* Proc. of the B. S. N. H., Vol. XXIII., March 5, 1884.

and speaks of them as oozoa, and in the preface to the English edition of his *Physiophilosophy*, Lond. 1847, Roy. Society, he writes that all organic beings originate from and consist of vesicles or cells. "Their production is nothing else than a regular agglomeration of Infusoria; *not, of course, of species previously elaborated or perfect, but of mucous vesicles or points in general which first form themselves by their union or combination into particular species.*" Oken's view was based on the resemblances existing between the Protozoa and the cells in the tissues of the Metazoa, and it is evident he is entitled to be considered the first teacher of the unicellular doctrine, an honor now universally given to von Siebold.

However imperfect and imaginative the results as compared with the more objective statements of later observers, the author who wrote such sentences as these had as clear ideas as the knowledge of his time permitted and was the Haeckel of the early part of this century, and like him a great and successful leader, making many errors but also many discoveries and 'blazing out' some of the paths that we are still following.

Meckel\* seems to have been the first author who brought together and stated in a clear way the scattered observations and ideas with regard to the correlations existing between the transient stages of development of the individual and the so-called permanent modifications represented by the similar characters in the adult stages of similar forms.

Meckel says: "Es gibt keinen guten Physiologen, den nicht die Bemerkung frappirt hätte, dass die ursprüngliche Form aller Organismen eine und dieselbe ist, und dass

\* Meckel. 'Entw. e. Darstellung der Embryonalzustände d. höheren Thiere u. d. Perman. d. zu d. niedern stattfindenden Parallele.' Beitr. z. vergleich. Anat., II., Leipzig, 1811, pp. 1-148; Meckel speaks of his publications as only preparatory to more extended researches.

aus dieser einen Form sich alle, die niedrigsten wie die höchsten so entwickeln, dass diese die permanenten Formen der ersten nur als vorübergehende Perioden durchlaufen. Aristoteles, Haller, Harvey, Kielmeyer, Autenrieth und mehrere andere haben diese Bemerkung entweder im Vorübergehen gemacht oder, besonders die letzten, hervorgehoben und für die Physiologie ewig denkwürdige Resultate daraus abgeleitet.

"Von diesen niedrigsten Wirbelthieren an bis zu den höchsten Geschlechtern lässt sich die Vergleichung zwischen dem Embryo der höhern Thiere und den niedern im vollkommenen Zustande vollständiger und treffender durchführen.

"In der That giebt es ja eine Periode wo der Embryo des höchsten Thieres, wie schon Aristoteles sagt, nur die Gestalt einer Made hat, wo er ohne äusere und innere Organisation, bloss ein kaum geformtes Klümpchen von Polypensubstanz ist. Ungeachtet des Hervortretens von Organen bleibt es doch noch wegen des gänzlichen Mangels eines innern Knochengerüstes eine Zeitlang Wurm und Mollusk und tritt erst später in die Reihe der Wirbelthiere, wenngleich Spuren der Wirbelsäule schon in den frühesten Perioden seinen Anspruch auf diese Stelle in der Reihe der Thiere beglaubigten."

It is very obvious, from these statements of Meckel's, that the correlations of embryology and the epembryonic stages of the individual with the permanent modifications of animals of simpler construction was understood, as far as was possible with existing knowledge, from the time of Aristotle and that it was, to a greater or less extent, a working hypothesis at that time and, as declared by him, had been helpful in giving a clearer understanding of the development of the individual and of the relations of the individual to the whole animal kingdom.

The next step was taken by von Baer, in dividing the animal kingdom into four types and in limiting this general statement to animals occurring within each of these types. He also considered it highly probable (not barely possible, as it is quoted by some writers) that the earliest stages of the embryo resemble in aspect the adult stages of the lowest grade of forms in the animal kingdom. He had in mind in this statement the modern view of the affinities of the earliest stages of the embryo or its repetitions of the characteristics of Protozoa,\* so far as the knowledge of his time permitted.

Von Baer endeavored to prove that each of the four types had similar embryos and that the type characters were determinable at early stages in the ontogeny. Both von Baer and Louis Agassiz were pupils of Ignatius Dollinger, an embryologist who published nothing. Both of these eminent men have recognized him as their master in embryology, but have given no definite statement of what they were taught by him. Louis Agassiz accepted von Baer's opinions and subsequently enlarged them, when he published on his fossil fishes by the introduction of the element of succession in time and thus laid the basis for all more recent work.

Agassiz gave the fullest expression of his views in 'Twelve Lectures on Comparative Embryology,' Lowell Institute, Boston, 1848-49, subsequently published in pamphlet form. One wonders as he reads how any man holding such views could have held his mind closed to the conclusion that animals were evolved from simpler or more primitive forms. The effect of theoretical preconceptions in closing the mind to the reception of new ideas never had a stronger illustration. Louis Agassiz, in 1849, had all the facts essential for building up a hypothesis of evolution that would have

\* Entwicklungsgesch. d. Thiere, Scholion V., p. 199, p. 120, etc.

placed him in the history of science on the same line with Lamarck and Darwin.

He states four lectures, p. 26, as follows: "The results thus far obtained in the lectures which I have delivered can be expressed as follows: There is a gradation of type in the class of Echinoderms, and indeed in every class of the animal kingdom, which, in its general outlines, can be satisfactorily ascertained by anatomical investigation; but it is possible to arrive at a more precise illustration of this gradation by embryological data. The gradation of structure in the animal kingdom does not only agree with the general outlines of the embryonic changes. The most special comparison of these metamorphoses with full grown animals of the same type leads to the fullest agreement between both, and hence to the establishment of a more definite progressive series than can be obtained by the investigation of the internal structure. These phases of the individual development are the new foundations upon which I intend to rebuild the system of zoology. These metamorphoses correspond, indeed, in a double sense, to the natural series established in the animal kingdom: first, by the correspondence of the external forms, and secondly, by the successive changes of structure, so that we are here guided by the double evidence upon which the progress in zoology has, up to this time, generally been based.

"Their natural series again correspond with the order of succession of animals in former geological ages, so that it is equally as true to say that the oldest animals of any class correspond to their lower types in the present day as to institute a comparison with the embryonic changes, and to say that the most ancient animals correspond with the earlier stages of growth of the types which live in the present period. In whatever point of view we consider the animal kingdom, we find its natural series

agree with each other; its embryonic phases of growth correspond to its order of succession in time, and its structural gradation, both to the embryonic development and the geological succession, corresponds to its structure; and if the investigations had been sufficiently matured upon this point, I might add that all these series agree also in a general way with the geographical distribution of animals upon the surface of our globe, but this is a point upon which I am not yet prepared to give full and satisfactory evidence. So much for the views referring to embryology in its bearing upon zoological classification."

And again on p. 27:

"However, another step had to be made to show a real agreement between the earlier types of animals and the gradual development of the animal kingdom, which has been the last progress in our science of fossils: namely, to show that these earlier types are embryonic in their character—that is to say, that they are not only lower in their structure when compared with the animals now living upon the surface of our globe, but that they actually correspond to the changes which embryos of the same classes undergo during their growth. This was first discovered among fishes, which I have shown to present, in their earlier types, characters which agree in many respects with the changes which young fishes undergo within the egg. Without entering into all the details of these researches, I will conclude by saying it can now be generally maintained that earlier animals correspond not only to lower types of their respective classes, but that their chief peculiarities have reference to the modifications which are successively introduced during the embryonic life of their corresponding representatives in the present creation. To carry out these results in detail must now be, for years to come, the task of paleontological investigations."

Perhaps, in consequence of pressure of other work or of his theoretical views, Louis Agassiz seemed to have lost sight of the great importance of continuing his researches upon the meaning and correlations of the epembryonic stages. These were referred to in his publications, but were not made as prominent as they deserved after the lectures at the Lowell Institute in 1849, and in his personal talks with his students or in his lectures I cannot remember that they were ever treated directly by anything more than incidental references, although embryology was very often the principal theme.

Nevertheless, I must have got directly from him, subsequently to 1858, the principles of this branch of research, and through this and the abundant materials furnished by the collections he had purchased and placed so freely at my disposal, I soon began to find that the correlations of the epembryonic stages and their use in studying the natural affinities of animals was practically an infinite field for work and discovery.

Although within a year after the beginning of my life as a student under Louis Agassiz I had become an evolutionist, this theoretical change of position altered in no essential way the conceptions I had at first received from him, nor the use we both made of them in classifying and arranging forms. This experience demonstrated to my mind the absurdity of disputing the claims of any author to the discovery of a series of facts and their correlations because of his misinterpretation of their more remote relations or general meaning. It is of some importance to notice this because it is the rule now to attribute von Baer's and his predecessors' and Louis Agassiz's discoveries in this line to Haeckel. This eminent author has, indeed, given one of the most modern definitions of this law and has named it the 'law of biogenesis.' Haeckel's

discoveries in embryology are sufficiently great without swelling the list with false entries, but it will probably be a long time before naturalists realize and acknowledge this error. Some of the most eminent embryologists in this country have adopted the Haeckelian nomenclature without sufficient critical examination of the term under discussion. The so-called Haeckelian ('law of biogenesis') is really Agassiz's law of embryological recapitulation restated in the terms of evolution.

It has surprised me that serious objections to the use of the word 'biogenesis' in this connection have not been made. This word has been long employed in another sense as antithetical to 'abiogenesis.' The latter has been for many years applied to the theory of the generation of living from inorganic matter, and the former to the theory asserting that living matter can originate only from living matter; the use of the phrase 'the law of biogenesis' is consequently inappropriate, since neither did Agassiz's nor Haeckel's discoveries cover so much ground. The former gave us a law for the correlations of the earlier stages of ontogeny with phylogeny. This cannot be called 'the law of biogenesis,' since that has been long ago stated as the law of the origin and continuity of organism, or in other words, the genesis and continuity of life from and through living matter only. There are two different manifestations of Agassiz's law, which Haeckel defined and named 'palingenesis' and 'conogenesis,' the former referring to the ordinary as regular mode in which the characteristics of ancestors are repeated in the development of the individual and the other to what is frequently called the abbreviated mode, etc.

These two modes are by no means all, but at present only the first or simplest manifestations of the phenomena need be treated of. This, or what Haeckel very

appropriately calls 'palingenesis,' was what Louis Agassiz had studied and, so far as all the essential facts were concerned, thoroughly understood, and it was this that he taught his students, so that it became, at any rate in my own case, the foundation of all my subsequent work in determining the mutual relations of forms. If then, as I have proposed in former publications, the term 'law of palingenesis' be adopted this expressly states just what Louis Agassiz discovered.

Observations upon this ground made especially upon Cephalopoda have led to the discovery of correlations between the latter or epembryonic stages and the adult stages of extinct ancestors which have greatly enlarged the field of application of Agassiz's law of palingenesis and given it an exactitude that has made it of surpassing importance in the study of evolution. Beecher has been able to point out the single species of Brachiopod from which the whole of the vast number of distinct forms of this great group have originated. He has established this fact not only by showing that the young of the existing and fossil forms all repeat more or less at one stage the form of the adult of the initial species, but has also found a very near affinity of this single ancestral species as a fossil appearing in one of the earliest of the fossil-bearing formations.

Dr. R. T. Jackson has done the same work for the Pelecypoda, tracing all to one genus, *Nucula*, and has treated the Echinodermata in the same way, tracing them by the use of Agassiz's law to the genus *Bothriocidaris*.

Although the evidence is perhaps less conclusive with reference to the ancestor of Cephalopoda as a whole, this class has furnished the means of showing the action of this law in smaller groups with great accuracy. It has been possible to trace the origin of a number of smaller groups to single an-

cestors within the class by carefully studying the correlations of the epembryonic stages with the adults of the same group that have preceded them in time, and this study has also led to further discoveries. It has been found that the new characters were first introduced in the later stages of ontogeny, usually in the full-grown stage; then, as old age approached, certain losses of the characters of the adult took the place, or, if additional growths were acquired, these were of a peculiar kind. These senile stages had been noticed by D'Orbigny and Quenstedt, but these authors did not attempt to show that any correlations existed between any stages of the ontogeny and the gradations occurring in the full-grown forms during their evolution in time, or what is called phylogeny. The oldest stage of the shell in Cephalopoda, Brachiopoda and Pelecypoda is commonly marked by a series of retrogressive changes, which have been fully described elsewhere. These changes have a similar nature to those found in the old age of man, but they are more noticeable because they are recorded in the permanent characters of the hardened shell. The old man returns to second childhood in mind and body, and the shell of the cephalopod has in old age, however distinct and highly ornamented the adult, very close resemblance to its own young. This resemblance is a matter of form and aspect only, since there can be no close comparison in minute structure, nor functions between organs and parts at these two different ends of life. Such analogies, however, have their own meaning and are of great importance when properly translated.

In the first place they show that the cycle of life as manifested in man is found also in the ontogeny of other animals and more perfectly in proportion to the perfection of the record. They are consequently among shell-bearing animals, especially those that carry their embryonic shells and

all their subsequent stages of development throughout their lives, more perfect, more decisive, as well as more obvious, than in animals, like the vertebrata, which carry no such burden of hard, dead parts upon, and in which their stages of development are recorded. The cycle of the ontogeny is, therefore, not only physiological, but it is also a definite series of structural changes and is often accompanied by transformations of remarkable and sometimes startling character.

These retrogressive transformations in old age of the shells of Cephalopoda, Brachiopoda and Pelecypoda have been found to have decided correlations with the adult characters of species that appear simultaneously or later in time. If one traces any group through its evolution in time it has, as stated by many authors, a period of rise called the epacme, a second period of greatest expansion in numbers of forms and species called the acme, and then usually a movement towards contraction called the paracme. All three of these terms were first proposed by Haeckel, who used them largely in a physiological or dynamical

The paracme is the decline, and this takes place through the reduction and actual loss of structures and characteristics that have been built up by evolution during the epacme. This is no ideal picture, but a simple statement of the experiences of those paleontologists who have patiently traced the history of groups through geologic time. Agassiz's law enables one to follow the epacme of the evolution of a species, or genus, or order, or larger group, but further correlations between the cycle of individual life and those in the evolution of its own genetic group must be sought in the correlations existing between the older retrogressive stages of the ontogeny and the paracme of each group.

The importance and peculiar nature of these correlations led me, in one of my papers, to introduce, for this branch of research, the term Bioplastology, which will be found convenient by those interested in this class of work.

The following table of terms is useful here to explain the relations of the cycle of development in the individual to that of the group to which it belongs.

TERMS OF BIOPLASTOLOGY EXPLAINING THE CORRELATIONS BETWEEN STAGES OF THE ONTOGENY AND THOSE OF PHYLOGENY.

Ontogeny or Development		Phylogeny or Evolution of the Phylum		
Structural Conditions	Stages	Structural Conditions	Stages	Dynamical
Anaplasia	{ Embryonic. .... Embryo or Foetal Nepionic. .... Baby Neanic. .... Adolescent	Phylanaplasia	{ Phylembryonic Phylonepionic Phyloneanic	Epacme
Metaplasia	Ephebic. .... Adult	Phylometaplasia	Phylephobic	Acme
Paraplasia	Gerontic. .... Senile	Phyloparaplasia	Phylogerontic	Paracme

sense. The epacme of any group, large or small, is usually a process of evolution by addition of new structures or characteristics based on older structures and thus leading to greater and greater complication of the primitive organization. The acme represents the time of greatest complication in structure and greatest expansion in numbers of forms for any group, large or small.

The dynamical terms are quoted from Haeckel and were used by him to designate the phenomena of the rise and decline of types, and also the terms anaplasia and metaplasia. He, however, used 'cataplasia' in place of paraplasia, which is here preferred on account of the faulty derivation of cataplasia.

He realized the importance of these phe-

nomena and also the significance of the structural characteristics of decline, but did not trace out the distinct correlations which are claimed as fundamentals in bioplasytology.

The terms anaplasia, etc., and their correspondence, phylanaplasia, are the structural correlatives of dynamical terms, epacme, etc., and will be found useful when the statical phenomena or structures are mentioned or contrasted with the dynamical phenomena, or with periods of time in which they occur, since the terms epacme, acme and paracme also refer to time. Terms of the ontogeny are placed opposite to their correlatives in the column of phylogenetic terms, but in reading the table it should be clearly understood that the individual whose life history is represented by the first three columns is supposed to have been taken from the midst of those that lived during the acme of the phylum and belonged to a phylephobic species. In studying the development of such an individual it has been repeatedly observed that the embryo repeated the adult characters of the most ancient representatives of the phylum, which are here called in accordance with this evidence, phylembryonic.

It has also been ascertained that there are full-grown types in the epacme and acme of groups which correspond to the transient nepionic or baby stage of those that occur later in time; these are the phylonepionic; others have similar correspondences with the neanic stages and are properly designated as phyloneanic types or forms. The structures of the ephebic (adult) stage are essentially the differentials of the time and fauna in which they occur, and necessarily have no correlations with the past. Their relations are obviously and wholly with the present, except in so far as they represent the consummations of evolution in structures. The structural

changes in the gerontic stage of the individual are repeated with sufficient accuracy in the adult, and often even in the neanic stages of types that occur in the paracme of the evolution of a phylum, so that one is forced to consider seriously whether they may not have been inherited from types that occur at the acme of the same group. The fact that these changes occur first in the ontogeny during the gerontic stage does not necessarily imply that they first make their appearance after the reproductive period. No gerontic limit is known to the reproductive time in the lower animals, and it may well be that the continual recurrence of gerontic stages in individuals during the epacme of groups may lead to their finally becoming fixed tendencies of the stock or hereditary in the phylum, and thus established as one of the factors that occasion the retrogression or paracme of groups. The paracme may also be considered as occasioned by changes in the surroundings from favorable, as they must have been up to acmatic time to unfavorable during the succeeding paracmatic period in evolution. Still a third supposition is also possible, viz., that the type, like the individual, has only a limited store of vitality, and both must progress and retrogress, complete a cycle and finally die out, in obedience to the same law.

All of these views can be well supported, but, whatever may be the true explanation, it is obvious that there are plenty of paracmatic types, which, in their full-grown and even in their neanic stages, correlate in characters and structures with the characters and structures that one first finds in the transient gerontic stages of acmatic forms of the same type. These can, therefore, be truthfully and accurately described as phylogenetic in the phylum.

In other words, one is able to apply gerontic changes in the ontogeny to the deciphering of the true relations, the ar-

angement and classification forms occurring in the paracme, just as Agassiz's law of palingenesis can be used to explain the relations of the links in the chain of being forming the epacme of groups.

The cycle of the ontogeny is, therefore, the individual expression and abbreviated recapitulation of the cycle that occurs in the phylogeny of the same stock, and, while the embryonic, neopionic and neanic stages give us, in abbreviated shape, the record of the epacme, the gerontic stages give, in a similar manner, the history of the paracme.

The difference between the nature of the two records is, however, necessarily as great as between the beginnings and the endings of existence. The successive stages of the individual are derived from the past, and simply point backwards along the track traversed by the phylum; the successive changes of the gerontic stage on the other point to the future, and are prophetic of what is to come in the decline of the type. The retrogressive decline of the individual and of its type are along parallel lines and the two are in direct correlation, so that the former becomes an abbreviated index of the latter.

One of the most useful results of these studies has been the method of work developed, the mode of study by series. To follow it out successfully one must trace the terms of series from the first, or most primitive, grade to the last, through perhaps long periods of time and, if upon the same level, through many gradations of structure.

The histologist and embryologist picks out a convenient form here and there for thorough investigation, but does not seem as yet to see the importance of the point of view here insisted upon, viz., that the only method of getting at the correlations of ontogeny and phylogeny is by following out the history of representative series of genetically connected embryos, and the

same is true of the experimentalist. While, consequently, their results have been in the highest degree instructive and progressive along other lines of research, they throw no very strong light on the laws of evolution, and the best modern works on embryology, zoology and experimentation neglect the only proper and efficient mode of studying one very important side of their subject.

One of the results of this mode of study has been the discovery of the law of acceleration in the inheritance of characters, or tachygenesis. Thus it has been found that characteristics are inherited in successive species or forms in a given stock at earlier and earlier stages in the ontogeny of each member of the series. These characteristics, as a rule, disappear from the ontogeny altogether in the terminal, or last-occurring, members of a series, and terminal forms thus become very distinct in their development. This law I habitually illustrate as the crawling, walking, hopping, skipping and jumping law.

Another result of this mode of study is the discovery that, in most genetic series, primitive forms exhibit much greater indifference to geologic changes, persist with comparatively unchanged structures through longer periods of time than those that occur at the acme of groups, and paracmatic forms, if widely distributed, are apt to be particularly short lived, and are very often narrowly localized in origin and duration. Primitive forms are also less changeable in their ontogeny; the adult differs less from either the young or the old than in acmatic forms. The same is true of phylogenetic forms; their old age and youth are less distinct as stages from each other than in acmatic forms. Primitive forms are less affected by gerontic changes in their ontogeny, *i. e.*, they have shorter old-age stages than acmatic forms. Paracmatic forms have much longer old-age or gerontic stages than acmatic forms.

Lastly, it has been found that at the beginning of the evolution of any stock the progress was not only very rapid, but the departures in structures much more marked between the diverging lines of different species, genera or families, and so on, than those that subsequently occurred in any one of these. This rapidity of expansion is also marvellously sudden in every series near its point of origin, and it is equally so in the whole animal kingdom, which appears with the larger proportion of all its principal divisions in the earliest known fossil-bearing rocks. Each series or type appears to have had a more or less free field, and its first steps in evolution were obviously not affected by natural selection. Subsequently, in the acme of the same series or type, the departures became less marked, and the divergences took place in less important structures; in other words, as stated above, the evolution is slower.

On the other hand, after the acme is passed and the paracme sets in, there is a sensible quickening of evolution during decline.

Phylogenetic forms become more and more numerous, and there are wider departures in the structures from the acmatic forms than any of the divergences that occur within the acmatic forms themselves.

The hopping, skipping and, at last, the jumping begins in the extremes of the series, so that it becomes difficult, as has been shown by the author in a number of series and by Cope when giving illustrations of the action of the law of tachygenesis, to connect one of these extreme forms with its nearest congener.

The characters of the cycle in the ontogeny are here again similar to those of the phylogeny; thus the final substages of the gerontic stage are wider departures from the ephobic substages than these are among themselves and when compared with each other. The analogy of the old with the

young shows this most conclusively and with the similarity of phylogenetic forms in the same stock occurs a parallelism in the phylogeny.

In fact, there is no end to the homological and analogical similarities and parallelisms of ontogeny and phylogeny wherever both are found complete.

There are types in which the ontogeny is incomplete, as among insects and other purely seasonal animals, and in these it becomes difficult, if not impracticable, to study the gerontic stages, and thus translate the phylogenetic types if they occur. These same types, and others also, present difficulties in their larval stages, owing to their indirect modes of development, which have been discussed by the author in *Insecta* and other publications, and need only be referred to here.

One of the bearings of these researches is of interest on account of the discussions between biologists, geologists and mathematicians with regard to the length of time that life has existed on this planet and the bearing of this upon calculations with regard to the age of the earth. It cannot be assumed that the time ratio was the same during the eozoic or pre-Paleozoic as during the Paleozoic or the Mesozoic, so far as the evolution of forms is concerned. The evidence is very strong that great structural differences were evolved much more quickly in these early times, and the probabilities are that the progressive steps of the evolution of the primitive types of organisms took place with a rapidity unexampled in later ages. If the laws of bioplastology are true the evolution of these forms must have occurred more quickly than those of their descendants, except perhaps some isolated phylogenetic types and phylopathic forms.\*

\* The phrase 'evolution by saltation' has been used for the sudden appearance of divergent types by several authors, first by Dr. W. H. Dall; but this seems

The author in other publications has claimed that this must have been the law, and explained the phenomena as parallel with that which takes place at the beginning of every series arising in the Paleozoic and Mesozoic, and also according to Minot's law of growth and other phenomena of the earlier stages in the ontogeny of every animal.

All inferences with reference to the length of time that life has existed upon the earth are consequently defective, since, as far as known to the author, they do not take into consideration the differing rates of evolution at different times in the history of organisms.

ALPHEUS HYATT.

*THE BLACKBOARD TREATMENT OF PHYSICAL VECTORS.*

THE tedious part of geometrical reading is the need of searching for the letters which designate the lines. Frequently this is the chief difficulty in the demonstration. In a measure, the same is also true when a geometrical proof is to be written down, particularly where special vector symbols (*e. g.*, the  $[AB]$  of Möbius) are employed. There is, perhaps, no remedy for this in printed work; but in the classroom, with a blackboard available, coplanar vectors may be drawn in great variety at pleasure. I will therefore describe the following method of elementary treatment which, though it contains no essential novelty, is new, I think, from a pedagogic point of view, and for this reason not without value.

Of the four specifications which characterize a vector—position, quantity, direction, sign—the first three usually come within the range of indulgence of the average student; but with the sign he will have nothing to do. Thus it becomes necessary to the author to be simply a mode of expressing a general fact, or series of facts, that occur everywhere, and in all series more or less through the action of the law of tachygenesis.

to especially emphasize the latter, and this is done by putting an arrowhead on the proper end of it. A physical vector is thus fully given by an arrow of definite length, originating in a definite point and pointing in a definite direction. With this laid down insistently, the principle of vector summation is next developed\* in the usual way. Here, again, the sign quality needs to be accentuated. The origin of the first arrow is the given point of application. The origin of every other arrow is the point of the preceding, beginning with the first arrow already placed. If two vector systems are equivalent, this implies that if the free tail of each begins at a common point, then the free tip of each system must terminate in the same final point.

It is simpler to begin with the first kinematic vector, velocity, rather than with displacement. The inherent importance of the space relations is easily pointed out in the course of the development.

With these customary introductions it is my plan to write down vector equations on the blackboard just like algebraic equations, using for my terms definitely specified arrows. Thus I obtain consecutively:

*Sum:* The equation reads, for instance,

$$\textcircled{1} \quad \uparrow + \rightarrow - \swarrow$$

To change the direction of an arrow is to change the sign of the term. Hence (1) is identical with (2).

*Difference:*

$$\textcircled{2} \quad \uparrow - \leftarrow - \swarrow$$

or by transposing,

$$\textcircled{3} \quad \uparrow = \leftarrow + \swarrow$$

which may be tested by construction. Again from (3)

$$-\downarrow = \leftarrow + \swarrow$$

\* By supposing one of the vectors to be forming on a blackboard moving as specified by the other vector.

and by transposing

$$④ \quad \theta = \downarrow + \leftarrow - \nearrow$$

which is the *triangle of rest*.

*Change of velocity*: If in the following equation (5) the second term of the first member is given as having changed into the first, then the change of velocity is

$$⑤ \quad \downarrow - \rightarrow = \downarrow + \leftarrow - \nearrow$$

*Polygon of velocity*: If any number of velocities are given to be added,

$$⑥ \quad \downarrow + \rightarrow + \uparrow + \leftarrow = \nwarrow$$

which is the polygon of velocities, and all possible constructions are equivalent to a mere change in the order of the terms. If we change the sign and direction of the arrow in the second member of (6) and then transpose the term to the first member

$$⑦ \quad \downarrow + \rightarrow + \uparrow + \leftarrow + \nwarrow = \theta,$$

which is the polygon of rest.

*Acceleration*: That accelerations may be compounded like velocities students assert readily enough, but few really understand the assertion. Defining acceleration in the usual way, the product of a time factor and a vector is here encountered. But the time factor is scalar and can be fully given by an ordinary number. Let  $t$  be a sufficiently small interval of time. Then, for the case of linear acceleration, the equation reads

$$\frac{d(\downarrow - \rightarrow)}{t} = \frac{d(\downarrow + \rightarrow)}{t} = \frac{d(\nwarrow)}{t},$$

where the quantity in parenthesis is the observed change of velocity in the time  $t$ . The result merely calls for an increase in the length of the reduced vector,  $1/t$  times. The more general case corresponding to (5) may be taken at once, whence,

$$⑧ \quad \frac{d(\downarrow - \rightarrow)}{t} = \frac{d(\downarrow + \leftarrow - \nearrow)}{t} = \frac{d(\nwarrow)}{t}$$

Two accelerations of the general kind

may be compounded (using a common time  $t$  for brevity), as follows:

$$⑨ \quad \frac{d(\downarrow - \rightarrow)}{t} + \frac{d(\downarrow - \rightarrow)}{t} = \frac{d(\downarrow + \rightarrow + \downarrow + \leftarrow - \nearrow)}{t} = \frac{d(\nwarrow)}{t}.$$

The quantities really compounded are thus the velocities (ultimately displacements) and the effect of the scalar factor is a mere change of the length of the arrow produced.

The case of a finite acceleration and vanishing  $t$  is particularly remarkable.

*Momentum*: If  $m$  denote mass, we again have the product of a scalar and a vector, in which, therefore,  $m$  is fully given by a number. To compound

$$⑩ \quad m(\downarrow) + m(\rightarrow) = m(\nearrow)$$

we virtually reproduce (1). If the momenta are referred to different masses, as in

$$⑪ \quad m(\downarrow) + m(\rightarrow),$$

it will be necessary to change the length of each arrow before compounding. The proposition may be extended to the polygon of moments, etc., as already shown.

*Force*: If the interval  $t$  is sufficiently small, force is defined, in a general way, by

$$⑫ \quad \frac{m(\downarrow - \rightarrow)}{t} = \frac{m(\downarrow + \rightarrow)}{t} = \frac{m(\nearrow)}{t},$$

where in the first member the second term (vector) is changed to the first term in the time  $t$  for each particle of the mass  $m$ . The quantity compounded is again the product of a vector (velocity) and a scalar  $m/t$ . To compound forces we thus virtually compound velocities and increase the length of the arrow resulting  $m/t$  times. If two forces actuate  $m$  we have in the most general case

$$⑬ \quad \frac{m(\downarrow - \rightarrow)}{t} + \frac{m(\downarrow - \rightarrow)}{t} = \frac{m(\nwarrow)}{t}.$$

These forces might have been rated in terms of different masses,  $m$  and  $m'$ , and times,  $t$  and  $t'$ . In such cases the first resultant would be multiplied  $m/t$  times and the

second  $m'/t'$  times and the new vectors then compounded.

*Center of Mass:* To complete the subject of translational motion for an extended body the customary reference is made to the center of mass.

#### ROTATION.

The case of rotation is treated throughout in complete analogy with the foregoing. What was linear velocity constant throughout the body in the above is now angular velocity also constant throughout the body; what was mass  $m$  has become moment of inertia  $n$ , and what was force  $F$  has become torque  $T$ —formally speaking, of course. The results are reached in the usual elementary way.

The first proposition to be laid down is Lagrange's well-known elementary proof for the composition and resolution of angular velocities. This must be most carefully done; for if students growl at the sign of a translational velocity they break out in open mutiny at the sign of an angular velocity. Obviously the arrow is again necessary for the complete specification, and I am in the habit of using the sign of Mars (♂) for angular velocities, measuring the arrow from the center of the circle. As a rule, only one of a group of velocities need be so marked. If right-handed relations be postulated (the reverse is the rule in dynamics) then an eye looking in the direction of the arrow sees clockwise rotation around it as an axis, with a speed given by the length of the arrow.

Thus one obtains in succession :

*Angular velocity:*

$$\textcircled{P} \quad \overset{\rightarrow}{\text{I} + \text{---}} = \overset{\rightarrow}{\omega}$$

reproducing all the propositions (1) to (6) above. Stress must be laid on proposition (5).

*Angular acceleration:* Essentially like (8) and (9) above.

*Angular momentum, moment of momentum:* If  $n$  and  $n'$  be the moments of inertia the quantities to be compounded are, for instance,

$$\textcircled{Q} \quad n(\overset{\rightarrow}{\text{I}}) + n'(\overset{\rightarrow}{\omega}),$$

reproducing (10) and (11') above.

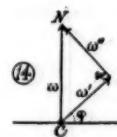
*Torque, couple, moment of rotation:* If  $t$  be sufficiently small, torque is defined in the most general way by

$$\textcircled{R} \quad \frac{n}{t}(\overset{\rightarrow}{\text{I}} - \overset{\rightarrow}{\text{---}}) = \frac{n}{t}(\overset{\rightarrow}{\text{I}} + \overset{\rightarrow}{\omega}) = \frac{n}{t}(\overset{\rightarrow}{\omega}),$$

where in the first member of the equation the second vectorial term (angular velocity) changes into the first term in the time  $t$  for every particle of the mass implied in  $n$ . Thus the propositions (12) and (13) are formally reproduced for rotations. In other words, torques, couples, moments are compounded just like forces, and the convention involved is the convention made in representing angular velocities.

I will conclude by giving a few examples, the first of which, *Foucault's Pendulum*, is cited merely as a concrete case of (1').

Let  $\omega$  be the earth's angular velocity. Let  $\varphi$  be the latitude of the place of observation. Resolve  $\omega$  as shown in figure.



Then  $\omega''$  rotates the plane of the pendulum around a line in this plane, horizontal for the place. Hence  $\omega''$  produces no deviation. Obviously  $\omega'$ , the deviating component is  $\omega \sin \varphi$ .

In physical meteorology the same result enters fundamentally into the theory of cyclones. For if  $2mV\omega$  be the deviating component of the earth's rotation for a circumpolar body of mass  $m$  and velocity  $V$ , then the corresponding component for any

latitude  $\varphi$  is  $2 m V \omega \sin \varphi$ , quite independent of the azimuth of  $V$ .

Again, if in figure (15)  $\omega$  and  $\omega_1$  be replaced by linear velocities, one easily obtains by (8) the expression for acceleration towards a center, etc.

*Precession*: In instruments like tops, gyroscopes, etc., the mechanism (supposed frictionless) is such as to exclude all interference from without, with the magnitude of the angular velocity  $\omega$  of the top around its axis. This constructive condition is essential. Hence, if the axis changes position, and

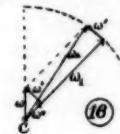


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if for brevity we suppose the tail of the arrow  $\omega$  to remain frictionlessly at  $C$ , then the locus of the point of the arrow must be the surface of a sphere of radius  $\omega$ . Let  $\omega$  change in position to  $\omega_1$ , let the axis to which the change of angular velocity  $\omega'$  (in figure 15) corresponds, pass through  $C$  and necessarily rotate around it in a horizontal plane. This is clearly the case with the axis of gravitational torque in the precessional motion of a top or gyroscope. Then must  $\omega'$  also lie in a horizontal plane, and the locus of  $\omega'$  is the surface of a circular cone with its axis vertical and its vertex at  $C$ . If  $\omega'$  is imparted in unit of time  $\omega'$  is the mean angular acceleration due to the gravitational torque and therefore equal to  $T/n$  by (12'). But the inclination of  $\omega$  to the horizontal has just been shown to be constant (cone), wherefore gravitational torque is constant and  $\omega'$  is constant. Hence the precessional motion is uniform rotation around the vertical axis of the fixed cone; for from one point of view  $\omega'$  is the total change of angular velocity due to gravitational torque, and from another point of view,  $\omega'/\omega$ , constant for the reasons specified, is proportional to the uniform angular velocity of

precession (see figure). If gravitational torque is withdrawn, as in a balanced gyroscope,  $\omega'/\omega=0$  and precession ceases. If  $\omega$  gradually decreases (friction),  $\omega'$  will subtend a relatively greater angle, or precessional motion will be accelerated, even when the axis of  $\omega$  is not lowered. In the latter case the result is accentuated, for gravitational torque is increased.

Again, suppose gimbals of a gyroscope forcibly rotated around a vertical axis. In Figure 16 let the angular velocity  $\omega$  be thus



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imparted in unit of time. Let  $\omega_1$  and  $\omega_2$  be the positions of the top axis and its angular velocities before and after the interference. Resolve  $\omega$  into components  $\omega'$  and  $\omega''$  respectively at right angles and parallel to  $\omega_1$ . Then  $\omega''$  would rotate the top axis if it were not frictionlessly mounted. It actually rotates the gimbals only. Therefore  $\omega_1 = \omega_2$  in length, as is otherwise evident. Thus  $\omega'$  is the total effective change of angular velocity, and in virtue of this  $\omega_1$  passes to  $\omega_2$  and the extremity of the top axis rises, describing a circle in a vertical plane. If  $\omega$  is imparted in a contrary direction the motion of  $\omega_1$  will be reversed. The top rolling on a blunt point belongs here.

Finally, if the top axis is forcibly rotated back and forth over a small angle around the horizontal axis of gravitational torque, similar considerations will lead to a better explanation of the curves drawn by a top on an inclined plane than I gave in a preceding article. The periodic changes of torque correspond to the rolling of the top up and down the inclined plane.

I have been tempted to enter somewhat at length into this most important subject,

because I failed to find an adequate account in such standard elementary text-books as came to my hands. Thus the explanation given in Daniell's physics is empiric and about within the limits of Perry's little book on tops. Ganot and Deschanel, Barker and Carhart, avoid the matter altogether. Kelvin and Tait's 'elementary' treatise has a single paragraph, intelligible at once, no doubt, to the authors. Peddie puts a slight expansion of this paragraph into his book. Even Violette's large new work says nothing about tops. In the German books, like Müller-Pouillet, Wüllner and the excellent treatise of Mousson, the phenomena are interpreted by aid of a suggestion of Poggendorff's, the very object of which is to dodge the principles of rotation involved under cover of a reference ('nur durch höhere Rechnung') to Euler. Yet gyrostats of diverse forms usually abound in physical cabinets. Supposing an instructor is not on the outlook for special entertainment for his children, of what use is such apparatus, I ask, if it be not to furnish the most striking tests imaginable of the truth of the above fundamental doctrines of rotation.

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ZOOLOGICAL NOTES.

NANSEN'S DISCOVERY OF THE BREEDING GROUNDS OF THE ROSY GULL.

Of the result of Nansen's Expedition thus far announced one of the most interesting, at least to ornithologists, is the reported discovery of the breeding grounds of Ross' Gull, also known as the Wedge-tailed or Rosy Gull (*Rhodostethia rosea*). In a letter published in the *London Daily Chronicle* last November, Dr. Nansen stated that he found flocks of Rosy Gulls on August 6th, in latitude  $81^{\circ} 38'$ , east longitude  $63^{\circ}$ . The birds were seen near four small islands called

'Hirtenland' by Nansen, a little northeast of Franz Josef Land. While Nansen did not actually find nests, he found the birds abundant, and concluded that their nests were probably near by. Every item of information regarding this rare bird is of interest, and in the December number of the *Ornithologische Monatsberichte* (pp. 193-196), Dr. Herman Schalow calls attention to the importance of Nansen's announcement and takes occasion to review briefly the history of the species.

There seems to be no reason to question the correctness of Nansen's determination of the birds or his surmise that they were breeding not far away. The wedge-shaped tail and the rosy tinge of the plumage (both noted by Nansen) are unmistakable characters of the species, and the presence of the gulls in such numbers in that high latitude renders it very probable that they were breeding. The Rosy Gull has long remained one of the rarest gulls. It was described from a specimen collected by Sir James Clark Ross in 1823, on Melville Peninsula, but in the next half century only a few individuals were taken and these in widely separated localities. In the autumn of 1881 Murdoch observed large numbers at Point Barrow, Alaska, apparently migrating from the west to the northeast. Although he secured a good series of specimens, he could add little to the life history of the species, and no other naturalist in Alaska has had the good fortune to meet with it in such numbers. This gull has also been taken in North America at St. Michael's, Alaska, and Disco Bay, Greenland, but it was not seen by the Lady Franklin Bay expedition. It was met with off the Siberian coast by the Jeannette Expedition, and was recorded by Payer between Nova Zembla and Franz Josef Land, only a few degrees to the south of the islands where Nansen found it.

The Rosy Gull is a typical arctic circum-

polar bird, reaching a latitude attained by few other species, and specimens taken outside the Arctic circle (at St. Michael's, Kamchatka, the Faeroe Islands, Heligoland, and Yorkshire, England) can only be regarded as stragglers. No one has yet been able to explain what becomes of the thousands which pass Point Barrow in the autumn, and less is known of the winter home of this gull than of the region where it breeds. Murdoch supposed that its breeding grounds were somewhere north of Wrangel Island. Nansen's observations seem to indicate that they are much farther to the west, but, as Schalow remarks, "when will man's foot again tread the dreary wastes of those high latitudes where one of the greatest rarities of northern oology is to be found?"

T. S. PALMER.

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#### ORIGIN OF PARASITISM IN THE COWBIRD.

REPRODUCTIVE parasitism, as we find it in our Cowbirds, is such a rare exception to the rule among higher animals, where parental affection is highly developed, that it never ceases to be an object of speculation as to its origin.

There are two peculiarities for which our Cowbird is renowned: The one which gives him his scientific name, *Molothrus*, a parasite; the other, which causes him to be called Cowbird, his strong attachment to grazing animals, especially horses and cattle.

Now, should there not be a connection between these two traits? Nobody would think that the habit of following horses and cattle has been formed since the introduction of these animals by the white man. Its Indian name, 'Buffalo-bird,' was certainly no misnomer, and it can hardly be questioned that for ages the buffalo, or American bison, was the animal which, in the economy of our cowbird, played the part now taken by the domestic animals.

The distribution of the one coincides in the main with that of the other, except that in recent years the Cowbird has extended its range to follow domesticated cattle. A few years ago the bison roamed over the greater part of eastern North America from the Atlantic to the Rocky Mountains, in suitable places, and it was not until the last century that it became exterminated in the territory east of the Mississippi river.

But the habits of the Cowbird were probably formed before the bison and the Red Man were on the scene, since some species in southern South America have similar traits.

The Cowbirds, like all other Icteridae, have their origin in South America, and of the twelve species and subspecies known only three enter the United States. Not all the species are parasitic; of some we do not know the mode of reproduction, but *Molothrus badius*, of Argentina, Paraguay and Bolivia, builds its nest and rears its young like other birds, and there was undoubtedly a time when *Molothrus ater* did the same.

We know that fossil remains of horses, not much unlike ours, are found abundantly in the deposits of the most recent geological age in many parts of America from Alaska to Patagonia. It was probably at that period that the Cowbirds acquired the habit of accompanying the grazing herds, which were wandering continually in search of good pasture, water and shelter, and in their seasonal migrations and movements to escape their enemies.

As the pastoral habit of the bird became stronger, it gave rise to the parasitic habit, simply because, in following the roving animals, the birds often strayed from home too far to reach their nests in time for the deposition of the egg, and, being hard pressed, had to look about for another bird's nest wherein to lay the egg.

After the acquisition of the roving habit,

it is not difficult to imagine that such cases occurred quite often, especially when, with the change of the climate, both birds and mammals spread more and more into the temperate regions where the spring movements of the grazing animals fell together with the bird's breeding time.

By a combination of favorable circumstances this new way of reproduction proved successful, and the parasitic offspring became more and more numerous. In the course of time the art of building nests was lost, the desire to incubate entirely gone, paternal and conjugal affection deadened, and parasitism had become a fixed habit.

O. WIDMANN.

CURRENT NOTES ON PHYSIOGRAPHY.

THE BRANCH STREAMS OF THE SCHUYLKILL.

MISS F. BASCOM recently discussed 'the relation of the streams in the neighborhood of Philadelphia to the Bryn Mawr gravel' (American Geologist, XIX., 1897, 50-57), with the object of determining the disputed age of the gravels from the amount of work done by the branches of the Schuylkill since the gravels were laid down. Wissahickon, Valley and Gulf creeks are explained as of superposed origin, because they flow at certain points transversely through narrow gorges in resistant strata. This conclusion tacitly postulates the occurrence of only longitudinal (subsequent) branch streams in the Schuylkill district before the gravels were spread over the region; it remains to be proved whether so perfect an adjustment of branch streams to structures is necessary. It is entirely conceivable that, before the gravels were deposited, the Cretaceous peneplain had some transverse streams, although most of its drainage may have well become longitudinal. Whether the Wissahickon could have maintained a transverse course so near the Schuylkill through both the Cretaceous and

Tertiary cycles of denudation is certainly doubtful, but it has not been proved impossible. Gulf creek and its neighbors are so distinctly rectangular in pattern that adjustment and re-adjustment suffice to explain them without superposition. The elements of doubt and certainty are here so blended as to illustrate the dangers as well as the values of river analysis as a means of deciphering geological history.

HANN'S ALLGEMEINE ERDKUNDE.

THE Allgemeine Erdkunde of Hann, Hochsöter and Pokorny now reaches its fifth edition. The first part, treating the earth as a whole, the atmosphere and the hydrosphere being still prepared by Dr. Julius Hann (Vienna, Tempsky, 1896, 336 p., 24 colored plates and 92 figures), while volumes on the earth's crust and its forms by Brückner, and on the distribution of plants and animals by Kirchhoff, are promised for 1897. Hann's revised volume impresses one as a thorough work by a competent author, useful as a text for an advanced collegiate course, or as a reference book for advanced students. It is questionable whether various elementary facts, such as the obliquity of the ecliptic, the variation of the length of the day and its cause, and the weather-map facts as to cyclonic circulation, deserve a place in such a work; for any one who is competent to use the rest of the book should have been for some years familiar with these fundamentals. The more serious subjects may be inferred from a rapid review of the contents; the size and shape of the earth, and their consequences in the variation of gravity and the determination of positions; terrestrial magnetism and auroras; the atmosphere, its temperature, pressure, winds, moisture, rain and weather—with less attention to the origin of cyclones than would be welcome; the ocean, its depth, composition, temperature—this treated in much detail—

currents, waves and tides. The book may be strongly recommended for a professor's library.

THE GEOGRAPHICAL ASSOCIATION.

A NUMBER of English schoolmasters have formed a Geographical Association, 'to improve the teaching of Geography in secondary schools by adopting any methods that tend to the comprehension of geographical principles rather than the accumulation of isolated facts.' The prevalent backward condition of the study in England can be inferred from the publication of an essay on 'Geography as a school subject,' by the Hon. Secretary, B. B. Dickinson (Lawrence, Rugby, 1896), 'an attempt to show that geography can be taught as a training of the mind.' It is curious to note that the element of training, as far as it is illustrated in this essay, is almost entirely derived from a consideration of climate, and that no disciplinary value is assigned to the study of land forms themselves. The treatment of the winds, under climate, is unsatisfactory; for example: "It can be explained in simple language that one effect of [the earth's] rotation will cause the atmosphere to be heaped up relatively high over the equatorial regions and low over the poles, and that this would lead to a gradual increase in the atmospheric pressure on the surface of the earth as we proceed from the poles to the equator." Again: "The pupils should carefully note how gradual is the falling-off of the heat received in the first  $45^{\circ}$  [from the equator], and how rapid it becomes with greater obliquities." Both quotations contain errors of statement that are inconsistent with good training. On the other hand, the attempt to connect human conditions with physical conditions is admirable; so admirable, indeed, that it should be uniformly extended all through the study of geography with as much care as is here given to the chapter on climate.

NOTES.

'THE Missouri river and its utmost source' is the title of a book by J. V. Brower (St. Paul, 1896), already known by his studies of the source of the Mississippi. This newer volume contains a little in the way of observation on the ground, but it is confused with a quantity of irrelevant matter, both in text and illustration. The text has less of physiographic matter than might be inferred from the title.

PROFESSOR A. A. WRIGHT, of Oberlin, has recently addressed the Ohio Academy of Science on the importance of establishing a topographic survey of that State. The educational, as well as the technical, value of the survey is emphasized, and a joint undertaking with the U. S. Geological Survey is recommended. The Academy approved the plan and appointed a committee of three to secure favorable action by the next Legislature.

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CURRENT NOTES ON ANTHROPOLOGY.

THE GAME OF MANCALA.

THE value of games, both as marking distribution within certain areas and as illustrating analogous lines of independent development, has been a fruitful study in the hands of Mr. Stewart Culin, of the Museum of the University of Pennsylvania.

His latest contribution is entitled 'Mancala, the national game of Africa,' and appears in the last Report of the United States National Museum (pp. 10, with illustrations). He believes that "it marks the limits of Arab culture," or, rather influence, and was historically disseminated by the extension of this Semitic people. He describes the modes of playing it and comments on its historical spread. It seems to have been known for some years in the United States under the name 'chuba.'

## ORIENTAL ITEMS OF ETHNOLOGIC INTEREST.

THE seventeenth volume of the Journal of the American Oriental Society contains several articles of ethnologic interest. One is the date of Zoroaster, which fixes the definite form of the Mazdeistic cult. This is placed by Prof. A. V. W. Jackson, in a very erudite analysis of the testimony, 'between the latter half of the seventh century and the middle of the sixth century B. C.'

Dr. John P. Peters defends with strong arguments the opinion that "the original home of civilization in Babylonia was the strip of land from Nippur southward to the neighborhood of Ur," and the founding of the city of Nippur "considerably antedated 6,000 B. C. and perhaps 7,000 B. C." That there were city builders among men that long ago is a most interesting result.

Prof. Haupt, in a critical analysis of the Judaic account of creation, adds to the evidence that it is 'specifically Babylonian' in origin.

Dr. C. P. G. Scott has some remarks on the 'universal' qualities of language, apropos of Malayan, a subject of the greatest anthropologic interest.

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## NOTES ON INORGANIC CHEMISTRY.

In a recent number of the *Zeitschrift für physikalische Chemie*, Debus criticises some of the conclusions of Roscoe and Harden in the 'New Views of Dalton's Atomic Theory.' He holds that in 1801 Dalton was led to the hypothesis that equal volumes of gases under normal conditions contain equal numbers of molecules, and that this hypothesis and his study of the oxids of nitrogen led him to formulate his atomic theory. In 1805 he abandoned his earlier views as to the equal number of molecules. Avogadro was probably aware of Dalton's views and borrowed his hypothesis, which is now known as Avogadro's law.

To the number of metallic carbids produced in his electric furnace by Moissan must now be added lanthanum carbid, C, La. It is, like most of the other carbids, decomposed by water and yields chiefly (71%) acetylene with 27% methane, a little ethylene and small quantities of liquid and solid hydrocarbons, thus closely resembling the carbid of cerium.

The last Proceedings of the Chemical Society (London) contain accounts of experiments of E. Sonstadt on sea water. As long ago as 1872 Sonstadt showed that the iodin in sea water is in the form of calcium iodate, four parts per million. His experiments not having been repeated by others, he now shows that an oxidizing substance must be present in sea water. He compares the oxidizing action of sea water on ferrous sulfate with that of sea water which has been deprived of iodates and similar compounds by evaporation and heating with mercury. He finds that the oxidizing quality of sea water is far greater than would be due to the presence of the iodate, and infers that other oxidizing substances are present. It seems ordinarily to be taken for granted that iodin is present in sea water as sodium iodid, analogous to chlorin and bromin, but, aside from Sonstadt, Balard and Pfaff are the only observers who have been able to even detect the presence of iodin in any form in sea water.

Sonstadt also shows that silver and gold can be detected in as small quantities as two liters of sea water, by continued agitation with mercury. The mercury on evaporation leaves a film partly soluble in nitric acid showing silver, while the insoluble portion dissolves in aqua regia and on cupellation gives a very minute bead of gold. Sonstadt concludes that, inasmuch as silver chloride is not decomposed by mercury, the silver may be considered to be present practically as metallic silver, and the gold probably in a similar condition.

H. N. WARREN contributes a short article to the *Chemical News* on calcium carbid as a new reducing agent. He finds that when it is heated with many metallic oxides they are reduced, forming generally alloys of the metal with a small amount of calcium. Even the oxides of chromium, molybdenum and uranium are readily reduced. Calcium carbid, which is so cheap, may come to replace for reduction the more expensive sodium or potassium.

M. GUNTZ, to whom has just been awarded the Saintour prize of the French Academy of Sciences, shows in a recent *Comptes Rendus* that the lithium nitrid obtained by him is not pure. Lithium combines directly with nitrogen, but the nitrid on formation dissolves a portion of the substance of the vessel in which the lithium is contained. Iron is least readily attacked; silver, platinum, quartz and graphite-carbon are readily acted upon, and cannot be used; hence all of the lithium nitrid formed is more or less contaminated by foreign matter.

J. L. H.

#### ASTRONOMICAL NOTES.

THE Nichols Press, of Lynn, Mass., has published a large quarto volume of 258 pages by Dr. T. J. J. See, entitled 'Researches on the Evolution of the Stellar Systems.' Dr. See gives a comprehensive account of the present state of our knowledge of the binary systems, and, while he includes but little matter which has not already appeared in print, he has produced a book which will certainly be of great interest to students of the subject.

The volume contains excellent accounts of the methods in use for the determination of binary star orbits, as well as reprints of Dr. See's own recent articles published in the *Astronomische Nachrichten*. These articles relate to the use of spectroscopic observations for the study of the binary stars and for the application of a rigorous test

of the universality of the law of gravitation. They have been criticised in the same journal in which they appeared, but in the present volume no notice is taken of these criticisms. Following the theoretical introduction, Dr. See gives his determinations of the orbits of forty stars, together with the observations on which they are based. We have not space to enter into a detailed criticism of this part of the book, but we are not sure that Dr. See's methods will meet with the complete approval of astronomers in general. Thus in the case of Zeta Sagittarii, Dr. See says: "While in Virginia recently I took occasion to measure this star, and, although the object was seen with difficulty, owing to its low altitude, I could discover a distinct elongation in the direction  $194^{\circ}7$ ; the distance could not be fixed with much confidence, but my settings of the micrometer gave  $0''35$ . The estimates of distance were substantially the same, but I am now convinced, from my distinct recollection of the appearance of the object, that both the measure and the estimate were too large." We doubt whether recollections of the appearance of a double star should have any place in the discussion of an orbit. Another thing which students might expect in the present work is a series of extended ephemerides computed from the orbits given by the author. But the ephemerides usually extend for a year or two only, and this circumstance will diminish somewhat the practical usefulness of the work.

THE observatory of Karlsruhe has issued the fifth volume of its publications. We find in it observations of stars south of the equator, made during the years 1892 to 1894, together with a catalogue derived from them. This volume is the last which will be issued from Karlsruhe, as the observatory has been moved to Heidelberg, where new buildings have been erected on one of the hills overlooking the Neckar valley.

WE have received the *Annuaire du Bureau des Longitudes* for 1897. It contains the usual mass of interesting statistical matter and a series of 'Notices' of more than usual interest. Three of the latter are by the late Professor Tisserand. They are entitled :

1. On the proper motion of the Solar System.
2. On the fourth meeting of the International Committee for the photographic chart of the heavens.
3. On the meeting of the International Committee for fundamental stars.

These notices by Tisserand have a sad as well as scientific interest, for they are followed by the orations delivered at his grave by Poincaré, Janssen and Loewy.

There is also a notice by Poincaré on the Röntgen rays, and one by Janssen on 'Epochs in the Astronomical History of the Planets.' These notices are not technical in character, and all are very interesting. The volume can be obtained for 30 cents, and should be in the hands of all persons interested in any department of astronomy.

WE note the appearance of the British Nautical Almanac for the year 1900. It is in all respects similar to the volume for the preceding year. In glancing over the preface of the work one cannot help noticing how small has been the use made of the theoretical researches of British astronomers. Probably not one formula or constant of importance is taken from a published research of English origin. And where results depend on observational series made in England these results are generally taken from discussions of the English observations by foreign astronomers. It is a truism that science is international, but truisms do not always penetrate government offices. The course of the British authorities must be highly commended, for they have used what they thought was best for science, without regard to the nationality of its origin.

H. J.

#### SCIENTIFIC NOTES AND NEWS.

PROFESSOR SIMON NEWCOMB and Lord Kelvin have been elected honorary members of the St. Petersburg Academy of Science. Lord Rayleigh and M. Callandreau have been elected corresponding members.

DR. ARTHUR AUWERS, the Berlin astronomer, has been awarded a gold medal by the German Emperor.

PROFESSOR JOSEPH LE CONTE, after attending the meetings of the American and British Associations for the Advancement of Science, and the autumn meeting of the National Academy of Sciences, and presiding over the annual meeting of the Geological Society of America, went to Milledgeville, Ga., and, at the place where he was married fifty years ago, surrounded by friends and relatives, including Professor W. Le Conte Stevens, he celebrated, on January 14th, his golden wedding. Professor Le Conte has now returned to the University of California. Although seventy-four years of age, Professor Le Conte retains all the energy and originality in research, publication and teaching which, during the past fifty years, have accomplished so much for the advancement of science.

HEINRICH GÄTKE, the veteran ornithologist, of Heligoland, died on January 1st, at the ripe age of 83. He is best known from his great work on Bird Migration, which contains the results of more than half a century of close observation at a single point—the rocky islet of Heligoland, in the North Sea. This small island is situated at a point where two great lines of migration meet, and is the most favorable spot known in the world for studying the periodic movements of a very large number of birds. Gätke's work is chiefly valuable as a record of facts of observation ; his deductions are not accepted by most American students of migration.

THE deaths are announced of Isidore Strauss, professor of experimental pathology, at Paris, and known for his important contributions to our knowledge of contagious diseases and bacteriology ; of Jean Hubert Thiry, formerly professor of surgical pathology in the University of Brussels ; of Dr. George Weyer, professor of mathematics and astronomy at the University

of Kiel, and of T. P. Morawitz, the entomologist of St. Petersburg.

We are glad to learn that Sir Joseph Lister, on being raised to the peerage, has selected the title of Lord Lister and will thus retain the name which he has made eminent.

THE German Emperor has conferred an order of the crown on Professor Linde, of the Polytechnic Institute at Charlottenberg.

THE Kansas Academy of Science, at its recent annual meeting at Topeka, placed the name of Chaplain John D. Parker on the roll of life members, as a recognition of his effective services in organizing science in the West. During the past thirty years he has been one of the founders of the Kansas Academy of Science, Kansas City Academy of Science, Nebraska Academy of Sciences and California Science Association.

THE budget of the Prussian government appropriates 50,000 Marks for investigation on the Röntgen rays. The money is to be used for apparatus to be divided into a number of special appropriations.

THE New York Aquarium at Castle Garden is visited daily by 7,000 people. This large attendance demonstrates the usefulness of such institutions for purposes of instruction and healthful amusement. It is understood that Mayor Strong is in favor of setting aside the land at Bronx Park for the Zoological Park, and it is much to be hoped that arrangements may be carried out without too great delay.

A DISPATCH from Teheran says that 2,500 persons perished as a result of the earthquake which occurred on Kishm Island, in the Persian Gulf, January 11th.

THE Friday evening meetings of the members of the Royal Institution are announced to open on January 22d, with a lecture by Professor Dewar, on 'Properties of Liquid Oxygen,' to be followed on the 29th by a discourse on 'The Polarization of the Electric Ray,' by Professor J. C. Bose, of Presidency College, Calcutta.

THE Geological Society of London will, this year, award its medals and funds as follows: The Wollaston Medal to Mr. W. H. Hudleston; the Murchison Medal and part of the fund to

Mr. Horace B. Woodward; the Lyell Medal and part of the fund to Dr. G. J. Hinde; the Bigsby Medal to Mr. Clement Reid; the proceeds of the Wollaston fund to Mr. F. A. Bather; the balance of the proceeds of the Murchison fund to Mr. S. S. Buckman; and the balance of the proceeds of the Lyell fund to Mr. W. J. Lewis Abbott and Mr. J. Lomas.

THE forty-fourth annual meeting of the American Society of Civil Engineers was opened in New York on January 20th, under the presidency of Mr. T. C. Clarke. The Norman Medal was awarded to Mr. J. E. Greiner for a paper entitled 'What is the Life of an Iron Railroad Bridge?' and the Rowland Prize to Mr. H. S. Coppee for a paper entitled 'Bank Revetment on the Lower Mississippi.' Mr. B. M. Harrod was elected President of the Society for the ensuing year.

THE building of the Bellevue Hospital Medical College, New York, was injured by fire on January 20th. The damage to the building is estimated at \$15,000, and much apparatus has been destroyed.

THE United States Civil Service Commission will hold an examination in Washington and in other cities where there are applicants, commencing on February 10th, to fill a vacancy in the position of expert horticulturist, office of experiment stations, Department of Agriculture, the salary of which is \$1,400 per annum.

PROFESSOR GIUSEPPE SANARELLI, Director of the Uruguayan National Institute of Experimental Hygiene, has reported, to the Academy of Medicine in Rome, the discovery of the bacillus of yellow fever. He will shortly publish the result of his experiments.

THE New York Board of Health has declared pulmonary tuberculosis, or consumption, an infectious and communicable disease, dangerous to public health. The resolution adopted by the Board ranks consumption with diphtheria and measles. The resolution makes it the duty of every physician to report minutely within one week to the sanitary bureau of the Board, concerning everyone sick with consumption whom he attends or who comes under his observation. Further, it orders every consumptive in the city, and every person attending a

consumptive 'to observe and enforce all the sanitary rules and regulations of the Board of Health for preventing the spread of consumption.'

RECODER GOFF, of New York, in speaking recently before the Medico-Legal Society, called attention to the very unsatisfactory condition of expert testimony before courts of justice. He had observed that juries were universally sceptical in regard to such testimony. He said that he would favor the establishment of a board which would select men who would be qualified to serve as experts.

A NEW quarterly journal, *Archives d'anatomie microscopique*, is announced by Masson et Cie. It will be under the direction of MM. Balbiani and Ranvier, and M. Henneguy will act as managing editor.

WE have already announced the new journal, *Monatschrift für Psychiatrie und Neurologie*, edited by Professors Wernicke and Ziehen. The first number has now been published at Berlin.

*La Nature*, the French weekly journal of popular science, will hereafter be edited by M. H. Parvil in place of M. Gaston Tissandier, who for twenty-five years has been its editor.

PROFESSOR JAMES SETH has become one of the editors of the *Philosophical Review*, published by Ginn & Co. for Cornell University.

REUTER's agency states that two Danish officers, MM. Oloufson and Philipsen, have just arrived in St. Petersburg on their return from a journey of exploration to the Pamir country, where they reached places hitherto untrodden by Europeans. They have brought back with them over 300 photographs of places they have visited and types they have met. During their travels they met, among others, tribes who are still fire-worshippers and totally uncivilized in their mode of life. The men of these tribes, and even their animals, are of very small size, the bulls and cows being no larger than a European foal, the donkeys about the size of a large dog, and the sheep about as large as a small poodle. The use of money is unknown to them, and their only trade consists in the bartering of furs. Women are bought at the rate of five or six cows or fifteen sheep apiece. These natives

are very timid, and on the approach of strangers take to flight. MM. Philipsen and Oloufson have secured numerous scientific collections, which they intend presenting to the Natural History Museum in Copenhagen, and have also made interesting meteorological observations. In the course of their voyage they occasionally reached a height of 14,000 ft. above the level of the sea.

ACCORDING to the London *Times* an electric omnibus, belonging to the London Electric Omnibus Company and propelled by electricity on the Radcliffe Ward system, has made a successful trial trip. Starting from Northumberland Avenue, it was able to ascend the comparatively steep slope of St. Martin's lane without any difficulty, although it was loaded with all but the full number of passengers it is constructed to carry and the streets were far from being in a good condition. In the crowded traffic of Oxford street it showed itself to be perfectly under the control of the driver as regards both steering and speed. It easily threaded its way among other vehicles and its pace could be regulated at will to pass almost everything else on the road or to crawl along with the slowest, while its powerful brakes enabled it to be pulled up dead within a yard or two. The pneumatic cushions interposed between the frame and the car do much to diminish vibration, and the smoothness and easiness of the running are in marked contrast to the uneasy rumble which usually accompanies London omnibuses.

THE results of the quinquennial census of France, taken on March 29, 1896, show a population of 38,518,975, an increase of 125,027 during the five years. The towns having more than 30,000 inhabitants show an increase of 320,000. Most of the agricultural districts, with the exception of Brittany, show a decrease.

THE London *Times* reports that the Council of the Royal Colonial Institute, for themselves and on behalf of about 4,000 Fellows of the Institute residing in all parts of her Majesty's dominions, have forwarded to the Prime Minister a memorial urging on the government the advisability of taking early steps for the unification

of time at sea, a question which has been brought under the consideration of the Council by the Royal Society of Canada. The memorialists say that the various points connected with civil, nautical and astronomical time at sea appear to have been fully gone into during the past twelve years by various societies and authorities in different countries, and to have been eventually resolved into the simple question of the desirability of advancing astronomical time by twelve hours so as to harmonize it with civil time, for nautical time has in general practice long been assimilated to civil time, and is no longer a matter giving rise to difficulty or discussion. It is believed by the memorialists that the proposed change can be easily introduced with decided advantage to observers, and that the general principle of the unification of time at sea has now an almost universal consensus of opinion in its favor. The advancement of astronomical time by twelve hours so as to assimilate it to civil time, in order that both may be in agreement and begin everywhere at midnight, would require the adaptation of the 'Nautical Almanack,' to the change, and as the 'Nautical Almanack' is of necessity prepared some years in advance, it is submitted that a decision should be arrived at by her Majesty's government with as little delay as possible, in order that the change may take effect at the date indicated by astronomers—viz., the first day of the new century.

THE general report on the operations of the survey of India during the year ending with September, 1895, according to *Nature*, shows that in this period the aggregate area surveyed on all scales amounts to 125,384 miles, exclusive of 5,018 square miles embraced by traverse operations in the central provinces and the north-western provinces and Oude. In the trigonometrical surveys the Upper Burma principal triangulation was carried northwards as well as westwards through Manipur and Assam. In addition to the topographical work accomplished during the year, a detachment with the Pamir commission surveyed 250 square miles, and one with the Chitral relief force surveyed in detail 450 square miles on the 1-inch scale, 215 square miles on the  $\frac{1}{2}$ -inch scale, and, approximately, 1,900 square miles on the  $\frac{1}{4}$ -inch scale. The re-

sults of the operations of the latter surveyors is that considerable knowledge of the topography has been gained of an area of 3,600 square miles of a country previously practically unknown, and much credit is due to Captain Bythell and the men who served under him for such a satisfactory record of work. Two views, representing the Malakand Pass and the Chitral bridge and fort, have been reproduced by heliogravure to illustrate Captain Bythell's report. A mass of information on the forest survey operations, cadastral surveys, traverse surveys, longitude observations, geographical surveys and reconnaissances, carried out by the survey department under the direction of Colonel C. Strahan, R.E., Surveyor-General of India, is included in the general report.

MR. GEORGE F. KUNZ, in his report to the United States Geological Survey on the productions of precious stones in 1895, states that among the more interesting occurrences and changes in precious stones for the year 1895 may be mentioned: (1) the finding of a 6-carat diamond at a new locality, Saukville, Ozaukee County, Wis.; (2) the diligent search made for monazite in North Carolina and Georgia, resulting in the finding of a number of interesting gems; (3) continued finding of rubies near Franklin, Macon County, N. C.; (4) the discovery of true blue sapphires near Utica, Fergus County, Mont.; (5) the discovery of some remarkable gem tourmaline of extraordinary size and wonderful perfection at the historic Paris Hill locality, Oxford County, Me.; (6) the finding of a large quantity of fine chrysoprase in Tulare County, Cal.; (7) the discovery of an enormous crystal of tourmaline on New York Island; (8) the interesting exhibition of Southern gems at the Cotton States and International Exposition, at Atlanta, Ga., and the presentation of this collection to the Lea collection at the United States National Museum; and (9) the opening of the Golden Gate Park Museum, at San Francisco, with an interesting collection of gems. Among foreign occurrences may be noted: (1) the increased yield of the South African diamond fields and the absorption of the entire yield by the gem markets of the world; (2) the occurrence of rubies of good color and in some abundance in various fields

in Siam; these are very rarely equal to the Burmese, yet they are fine stones, and, although generally much lower in price, a single stone sold for more than \$1,000; (3) the great profusion and beauty of the opal and the large demand for these stones, which were produced in greater quantity, finer quality and at a somewhat lower cost than ever before from the fields at Fermoy, Queensland, and in the new locality at White Cliff, in New South Wales.

THE article by Dr. Dabney in the issue of this JOURNAL for January 15th, pointing out the advantages of a National Department of Science, was prepared at the suggestion of Hon. Gardiner G. Hubbard, who wrote to Dr. Dabney as follows:

1328 CONNECTICUT AVE.,

WASHINGTON, D. C., January 3, 1897.

DEAR CHARLES A. DABNEY, JR., Washington, D. C.:

DEAR SIR: My attention has been called at different times during the past year to the great number of scientists employed by the government and the large amount of appropriations. I have also observed that the same subject seemed to be treated often under two and sometimes under three departments, thus leading to needless duplication of labor.

I know that your attention has been somewhat called to this subject. I, therefore, venture to ask you, if your time will permit, to prepare an article for publication, which shall bring out fully all these facts, and also suggest a remedy which would seem to be the placing all this scientific work under one department. I know of no one better fitted than yourself to perform this work and am sure that it will be carefully and correctly done.

Very truly yours,

GARDINER G. HUBBARD.

HON. CHARLES W. DABNEY, JR.,  
Assistant Secretary of Agriculture.

#### UNIVERSITY AND EDUCATIONAL NEWS.

THE New York Court of Appeals has decided the Fayerweather will case by affirming the judgment of the lower court. The residuary estate, now amounting to more than \$3,000,000, will consequently be divided equally among the twenty colleges named in the will. The following institutions will each receive more than \$150,000: Amherst, Bowdoin, Dartmouth, Williams, Yale, Columbia, Hamilton, Lafayette, Lincoln, Maryville, Marietta, Adelbert, Wabash,

Park, Wesleyan, Rochester, Cornell, Virginia, Hampton, and the Union Theological Seminary.

A NUMBER of professors of the University of Berlin have asked permission from the Senate to inaugurate a system of university extension lectures. It appears, however, that there is considerable opposition to the plan in Germany, in part because it is supposed that many university professors might favor the views of social democracy.

ACCORDING to the new *Prussian Budget* professors in the University at Berlin will receive an increase of salary of \$500 Marks, and smaller increases in salary are granted to professors in the other Prussian universities and to teachers in the schools.

MR. HAROLD HEATH has been appointed fellow in biology and Mr. J. M. Mathews fellow in chemistry in the University of Pennsylvania.

DR. E. WIECHERT, docent at the University of Konigsberg, has been promoted to a professorship. Dr. Willstatter, of Karlsruhe, has qualified as docent in chemistry in the University at Berlin.

#### DISCUSSION AND CORRESPONDENCE.

##### SIMPLIFIED SPELLING.

TO THE EDITOR OF SCIENCE: In a book notice sent to you to-day you will observe two instances of the innovation in spelling proposed by Funk & Wagnalls. Instead of 'grouped' and 'addressed,' I have written 'groupt' and 'addrest.' Unless special instructions are given, your compositor and proof-reader will ignore my attempt at reform and print these words according to the prevalent fashion. Of this I cannot complain, for it is certainly the privilege of a journal to unify its pages in the matter of spelling. Neither am I disposed to criticize SCIENCE for not joining in the spelling-reform movement, for it would be unwise for a journal with its own battles to fight to incur the odium which attaches to rational spelling. The prejudices in favor of irrational spelling are so strong and prevalent that they cannot be opposed without a certain measure of sacrifice on the part of the opponent. Nevertheless, it seems to me that SCIENCE may, without harm to itself, allow such of its contributors as have

joined in the Funk & Wagnalls' movement to reform their particiles in signed articles, and I, therefore, submit a request for permission.

G. K. GILBERT.

WASHINGTON, D. C.,

January 18, 1897.

AN EXPLANATION OF THE SO-CALLED PSEUDO-AURORA.

OCCASIONALLY, during the winter season, dwellers of our Northern cities have noticed by night a strange optical phenomenon, which some one has called the 'pseudo-aurora,' and which, so far as I know, has not been heretofore explained.\* My attention was first called to it some years ago, in Moorhead, Minn. Over each arc lamp, used in street lighting, appears a strange column of pure white light, seeming to extend vertically to a great height; a peculiar transparent shaft, like the brightest bars of the aurora borealis, yet standing very still, and always vertical over the lamp from whatever point viewed. When each arc lamp in the whole town is thus attended by its vivid shaft the display is magnificent and, seen against the northern sky, might easily suggest the 'pseudo' name. On an evening of special beauty these columns seem to reach almost to the zenith, and other sources of light add their shafts to the display. The evening star gives a shaft below as well as above, and the late rising moon stands right in a broad column of light.

Looking about for causes, and noticing from time to time the conditions under which this meteor appeared, the following facts were observed: The temperature is always below the freezing point, oftenest about zero. The sky is cloudless, air still or barely moving, and more or less full of frost crystals. The display is finer, completer, when most crystals are present, though by no means does the mere presence of crystals in the air furnish the spectacle. The shafts of light are most sharply defined and apparently higher when the air is still. With more wind the shafts spread out, diffuse, becoming indistinct, and with a gentle breeze the light seems to be more or less evenly distributed through the entire upper air, like a fine luminous dust suspended there.

\*See Loomis's *Meteorology*, p. 224.

Having noticed these conditions, it is apparent that the crystals are the important factor, and reflection of light from their facets is suggested at once. Of course to get a vertical shaft of light by reflection necessitates a constant horizontal position of the crystal faces, and I searched long and arduously for a ballasted crystal, floating like a parachute, but found none. What I did find in each case was a minute hexagonal plate of solid ice, in no case more than one millimeter in diameter, extremely thin, and of glassy smoothness.

I experimented with this idea: Making some hexagonal plates an inch across, of the lightest glazed bond paper, and letting them fall in still air from a height, the whole story is told. Each plate floats gently down, at times making a rapid chute edgewise, but quickly recovering a horizontal position, so that of all the time involved in falling, the larger part is taken up while the plate is in a position approximately horizontal. We have seen the same thing in autumn when the great basswood leaves let go and float slowly down.

Now, filling the air with such plates, each of which is a perfect mirror, we have in the vertical plane, between our eye and the light, innumerable crystals, from the lower surface of which rays of light from the lamp are reflected to our eye, and seen by the eye as though located in the straight line in which they enter the eye, and at a distance equal to the distance traveled from the lamp. This gives the vertical column, the location of any single point in it being shown by construction, the same as an image in a plane mirror.

The little crystal plate adjusts itself, like a flat stone at the bottom of the torrent, or a cake of ice at the top of the sea, with its broad surface normal to the force acting upon it. So long as this force is gravity only, the position of the crystal is horizontal. But if the wind be blowing this adds a horizontal component, giving with gravity a resultant no longer vertical, to which the plate becomes normal. With the departure of the crystal from the horizontal position the vertical shafts of light disperse.

J. PAUL GOODE.

UNIVERSITY OF CHICAGO.

## SCIENTIFIC LITERATURE.

*Catalogue des bibliographies géologiques.* Rédigé, avec le concours des membres de la Commission bibliographique du Congrès. Par EMM. DE MARGERIE. Paris, Gauthier-Villars et Fils. 1896. Pp. xx + 733.

The International Geological Congress, at its Washington meeting in 1891, appointed a standing committee on bibliography. The original membership was ten, but provision was made for enlargement by the committee itself, and there were eventually fourteen members, representing the principal countries or regions having geologic literature. North America was represented by Mr. Gilbert, and South America by Dr. Steinmann, of Freiburg, Baden. The duties of the committee, as instructed by the Congress, were: (1) to prepare and publish a list of existing partial bibliographies of geology; (2) to promote the preparation by geologic societies and surveys of bibliography pertaining to their respective territories, and (3) to study the problem of the systematic centralized publication of the current bibliography of geology. The first of these works was immediately undertaken and has resulted in an imposing volume of 750 pages.

When a cooperative work of such magnitude is carried to a successful conclusion there is usually some one individual to whose skill and energy the success is due, and in this instance that person was M. Emm. de Margerie, of Paris, the Secretary of the Committee. Under his guidance the other members of the committee gathered material from their respective countries or districts, but the whole was classified, unified, and eventually in large part verified through comparison with original sources by him. He, moreover, made a systematic search of libraries and was thereby enabled to make large additions to the list.

The whole number of entries is 3,918 and these are grouped under two 'parts' and many headings. The first part, with various subdivisions, includes bibliographies whose geographic scope is either the whole earth or one of its greater divisions. The second part includes the bibliographies of regions or countries, arranged alphabetically by regions. The regional entries are also classified according to scope and subject, and there are abundant of cross refer-

ences. This elaborate classification adds greatly to the convenience of the book, enabling the user to find in one place, or at most in two or three places, all references to any special subject of inquiry. His convenience is further consulted by the addition of three indexes, referring severally to authors, places and topics. The scope and method of each work listed, when not described in its title, are explained in the annotation.

A summary of the part pertaining to North America (United States and Canada) will at once illustrate the scope of the list and its mode of classification. General bibliographies afford 12 titles; catalogues of publications of official surveys, 38; general indexes of transactions and journals, 10; annual bibliographies, 9; library catalogues, 3; personal bibliographies and biographic notices, 51; bibliographies of special districts, 61; subject bibliographies, 70, of which 52 pertain to special formations, 1 to paleontology and 9 to petrography.

While the primary purpose of the committee was to take an account of stock in the field of geologic bibliography, and thus pave the way for the most intelligent undertaking of systematic and comprehensive work for the future, their catalogue has an immediate value to the investigator as a directory to the places where the literature he wishes to examine is listed.

The chief cost of publication was met by the local committees of the Washington and Zurich Congresses, and copies of the volume have been forwarded to the geologists who attended those meetings. This distribution has not entirely exhausted the edition, and the remaining volumes are placed on sale, the price for the United States and Canada being \$5.00. The Secretary of the Washington Congress permits me to add that the *Compte Rendu* of that meeting will be forwarded without cost to the American purchasers of the Catalogue. Correspondence should be addressed to

GEOLOGICAL SURVEY, G. K. GILBERT.  
WASHINGTON, D. C.

*The Principles and Practice of Teaching.* JAMES JOHONNOT. Revised by SARAH EVANS JOHONNOT. International Education Series, Vol. XXXIX., 12mo., pp. xx + 334. D. Appleton & Co., New York. 1896.

*Nature Study and Related Subjects for the Common Schools.* WILBUR S. JACKMAN, A. B. Part I. Charts, 4to, pp. 23; Part II., Notes, 12mo., pp. 167. The Author, Chicago. 1896.

These two books are of especial interest to teachers of science, for, even though the first is concerned with teaching in general, the author, nevertheless, lays especial stress upon the proper methods of science teaching. Although Johonnot's book originally appeared nearly twenty years ago, this revised edition seems fresh and new, not because there is much new matter incorporated in it, nor yet because the subject-matter has been materially changed, but rather because the original work contained so much that was true in principle and clear in expression. The system is based upon sound psychological principles and the book is a clear exposition of the scientific method of teaching. It contains chapters upon the general objects of education, the mental powers, objective and subjective courses of instruction, relative value of different branches of instruction, Pestalozzi, Froebel, Agassiz, systems of education compared, physical, aesthetic and moral culture, general course of study, country schools and their organization.

The most noticeable changes made by the reviser are in relation to manual training, moral culture and general courses of study, and are all in the direction of recent pedagogical opinion on these subjects. An appendix is added, giving an account of a school conducted upon the principles advocated by the author. Of his success we may judge from the following extract:

"Our experiment came to an end. Of the various innovations made upon custom each had justified itself. The effort to make character the end of education had more than fulfilled expectation. During the last year not a single case of misconduct was reported to me, nor was the behavior of one of our students criticised by the citizens. We had a reign of influence. The forces that govern conduct came from a growth within of just and kindly impulses. A watchful supervision had always been maintained, but into this had entered no element of espionage. The peculiar character

which the school attained, both on its mental and moral side, was due to the several factors of influence—scientific methods in study, philosophic succession of subjects and a never-ceasing but an apparently *incidental* attention to moral training."

Prof. Jackman's work consists of two parts, the first being a set of ten charts presenting a conspectus of nature study for the school year, and the second a series of notes and directions for the guidance of the teacher. The charts outline the subjects of study appropriate for each month of the school year from September to June inclusive, the subjects themselves being mineralogy, geology, astronomy, meteorology, chemistry, physics, geography, botany and zoology. Each subject is considered in the two aspects of thought work and form work. Under the former are included the subject, both general and special; the concept, to be considered from the study of the subject; collections illustrating the subject; apparatus required; reading from certain designated books containing selections for school use; literary treatment of the topic by recognized writers; the moral and aesthetic culture derived from the study. Under the head of form work the pupil's training is directed along the lines of the study of the geometrical form exhibited by the object; number, consisting mainly of statistics gathered by examining a large series of objects and bearing on various points; making or modeling the object or the piece of apparatus used; drawing the same; color, as shown in nature; writing upon some topic suggested by the thought work; language, including the study of descriptive phrases, figures of speech, technical terms, etc.; music, as illustrated by the appropriate school songs; references to standard scientific literature.

This plan of study as outlined above will at once be recognized as that of a teacher who has had long experience and has been guided by correct principles; of one who evidently believes that nature study develops something more than the powers of observation, and if properly conducted may be the means of cultivating all the mental faculties. The plan itself is exceedingly comprehensive and varied. In the hands of a conscientious and well-trained

teacher it ought to give admirable results. Each subject is considered from so many points of view that it seems scarcely possible that the pupil could lose interest in the work or fail to see the intimate relation between the great number of natural phenomena and the daily affairs of life. The pupil's attention is held throughout the course of study by interesting him in some aspect of nature especially noticeable during the different seasons. To illustrate, the plan contemplates the following subjects for study during the month of October: In zoology, the migration of animals; in botany, the distribution of seeds; in geography, areas of crops sown in the autumn; in physics, evaporation and condensation; in chemistry, ash, organic matter, fluid and dry solid in common fruits; in meteorology, rainfall and humidity; in astronomy, distribution of sunshine; in geology, erosion and sedimentation, the transporting power of water; in mineralogy, evaporation of water from the soils, and sand and granite.

The notes composing Part Two of the work, though, perhaps, rather too rhetorical in treatment, present to the teacher directions for the construction and use of apparatus, descriptions of experiments and suggestive examples illustrating the tremendous scale upon which the operations of nature are conducted. While in most cases the directions are sufficiently explicit, much is left, and properly, too, to the individual teacher to plan and execute as circumstances may require.

Few teachers realize how much can be made of nature study if properly conducted, and, as Prof. Jackman's plan does not require for its execution that the teacher shall be specially trained in the sciences, it is hoped that it may be widely adopted.

CHARLES WRIGHT DODGE.

UNIVERSITY OF ROCHESTER.

*Papers presented to the World's Congress on Ornithology.* Edited by MRS. E. IRENE ROOD, under the direction of DR. ELLIOTT COUES. Chicago. 1896. 8vo. Pp. 208. \$5.00.

The 'Congress' at which were presented the twenty-seven papers printed in this volume took place in Chicago in October, 1893. Invi-

tations to it had been widely distributed, signed by a committee of nearly a dozen persons, of whom Dr. Coues is the only one well known as an ornithologist. In the invitation it was announced that the congress was to 'treat of birds from the standpoint of the scientist, the economist and the humanitarian,' and the scientist was warned that the audiences would be characterized by 'aesthetic feelings and humane sympathy rather than intellectual apprehension.' Under these circumstances it is not surprising that the papers show a very wide range of merit, nor that among their writers there are but few ornithologists of much prominence.

Several of the articles are deserving of cordial praise. Mr. D. P. Ingraham, for instance, gives a very interesting account of the American Flamingo, a bird that few other naturalists have seen within the limits of the United States, where to-day it is restricted to the inaccessible, shallow bays of the extreme southern coast of Florida. Another valuable contribution is that on the changes of habits of some birds in Maine, by Manly Hardy, whose many years of exceptionally careful observation have enabled him to narrate a number of instances of adaptation to changed conditions. Somewhat comparable with Mr. Hardy's notes are those of Mr. J. H. Bowles, upon instinct in birds, though of less importance, for the reason that reliable facts of this sort are far more readily attainable than such as Mr. Hardy's, which, from the nature of the case, are seldom afforded save by the life-long experience of a single observer.

The late John S. Cairns contributed a short sketch, giving a good account of the breeding haunts of the Black-throated Blue Warblers on the mountains of western North Carolina. In mentioning the fact that in the spring these birds are already engaged in nest-building at a time when northern-bound individuals of the species are still migrating through the valleys below, he incidentally referred to them as a 'local race.' This calls forth the following editorial foot-note: "As this subspecies does not appear to have been named, it may be called *Dendroica caerulea cairni*.—E. C." Readers of the book may be interested to learn

that this has proved to be one of Dr. Coues's happy intuitions, and that his *nomen nudum* only awaits a description to take a secure place in ornithological nomenclature.

Dr. Emil Holub's brilliant description of a winter roosting place of *Hirundo rustica* must not pass unnoticed, nor must Mr. J. A. Allen's article on 'the migration of birds.' The latter is an exposition of the subject excellently suited to the unscientific reader, for whom, doubtless, it was intended, but it contains one or two statements that the field ornithologist of large experience might not assent to. Among the rest of the papers there are some, of which there is nothing especial to be said; others might better never have been written.

C. F. BATCHELDER.

SCIENTIFIC JOURNALS.

JOURNAL OF GEOLOGY, NOVEMBER-DECEMBER, 1896.

*Age of the Auriferous gravels of the Sierra Nevada:* By WALDEMAR LINDGREN; with a *Report on the flora of Independence Hill:* By F. H. KNOWLTON. An attempt is made to definitely fix the age of the auriferous detrital rocks of the Sierra Nevada, resting unconformably upon the bed rocks at high elevations and covered by volcanic flows. The beds include the deep gravels, the bench gravels, rhyolitic tuffs, gravels of the rhyolitic period, gravels of the inter-volcanic erosion period and andesitic tuffs and tuffaceous breccias. No fossils have been found in the deep gravels. They are older than the bench gravels, and may be as old as the Eocene. At Independence Hill leaves occur in a whitish or bluish clay interbedded with the uppermost gravels of the antevolcanic period. These plant forms point very clearly to the Miocene age of the deposit. The Ione formation, correlated with the bench gravels, is also shown to be Miocene by the presence of characteristic shells. These gravels are probably Upper Miocene. The gravels of the inter-volcanic period and the andesitic tuffs are probably Lower Pliocene or Upper Miocene. In early Cretaceous the Mariposa and earlier beds were folded and eruptions were continued from the Jurassic. Shortly before the Chico the

Sierra Nevada became separated from the Great Basin. In Chico time the sea advanced eastward. In late Chico and Tejon time the Sierra Nevada was being eroded, the greater part of the Chico sandstone being cut away. In early Miocene the sea retreated westward. The Sierra assumed the topography since preserved. The relation of the two eroded surfaces, Cretaceous and Miocene, is clearly discernible from the lower foot hills. In late Miocene (Ione) the sea moved eastward and gravels were formed. The gravel period was closed by rhyolitic and andesitic eruptions with Pliocene elevation. The andesitic flows are supposed to mark the close of the Pliocene. The Pleistocene was a period of erosion, with minor basaltic eruptions in the earlier and middle portions, and glaciation later.

*Anorthosites of the Rainy Lake Region:* By A. P. COLEMAN. Lawson has described eruptive masses through the Keewatin of the Rainy Lake region. The basic eruptions were identified as anorthosites, the larger area enclosing the southern arm of Bad Vermilion Lake. The rock presents some differences from typical anorthosites, an analysis showing that it is one of the most basic rocks. Lawson thought the area represented the truncated base of a Keewatin volcano. In this he was probably not correct, as apparently a long interval separated the anorthosite eruption from that of the granite.

*Mechanic of Glaciers I:* By HARRY FIELDING REID. The greatest flow occurs through a section at the névé line, and diminishes as we go up or down the glacier from here; the diminution increasing with the distance from the névé line. In glaciers with beds of uniform slope the velocity and flow increase and decrease together, though not in the same proportion. In a glacier of indefinite length and uniform section the direction of the flow would be parallel to the slope, and the velocity parallel with the axis would not vary along the direction of flow. The velocity of a point under such circumstances would be the normal velocity corresponding to that form and size of cross-section. A glacier of uniform section could not exist if there was any melting; the slope of the glacier being uniform, wherever there is melting, the

cross-section must change to produce a smaller flow as we descend the glacier. The ice near the lower end of the glacier is under greater pressure than the normal pressure and would therefore have a tendency to rise. Stratification is not easy to recognize, but certain observations support the view that this potential rising becomes actual, which accounts for many of the phenomena observed. The surface at any point depends on velocity and rate of melting, and varies inversely with them. The larger the glacier the greater will be the differential motion. For small glaciers the differential motion is small and the slope steep. If anything cause an abnormal melting of the lower layers the upper ones will advance but over them, which is thought to be the explanation of certain facts observed in Greenland by Chamberlin and Salisbury. Although the sloping surface of Alpine glaciers is a surface of equilibrium it is unstable. If the surface be in equilibrium it will respond quickly to climatic variation. If it be widely removed from equilibrium it will respond more slowly, an explanation of the variation of glaciers differing from both that of Forel and Richter.

*Loess in the Wisconsin Drift Formation*: By R. D. SALISBURY. Loess has long been known to cover the glacier drift of the earlier epochs at various points. At least two loess sheets are known, one of which is correlated with Iowan ice and passes beneath the Wisconsin. Heretofore loess has not been known to occur in or above the Wisconsin drift, but during the past summer it has been found in connection with this formation at several points in Wisconsin, namely, Green Lake, Devil's Lake and Ablemans.

*Geology of Chiapas, Tabasco and the Peninsula of Yucatan*: By CARLOS SAPPER, translated by C. JOAQUINA MAURY and G. D. HARRIS. Southeastern Mexico shows three series of formations: an ancient complex of Palaeozoic beds and eruptives in southern Chiapas; a more modern belt of Mesozoic and Tertiary formations in the middle and northern regions; and a third zone of great plains at the foot of the other belts, only slightly elevated above sea level, and of Quarternary age. In the peninsula of Yucatan there is less diversity and the

beds are undisturbed, in which regard they are contrasted with those of Chiapas. Descriptions of the various formations, with lists of fossils, are appended.

*Studies for Students—Stratified Drift*: By R. D. SALISBURY. Water must have been an important factor in the deposition of the drift, particularly along the margin of the ice. A much larger amount of drift is stratified than is commonly thought. These deposits include extraglacial, supermorainic, submorainic and intermorainic stratified drift. The deposits made during the advance, maximum extension and retreat of an ice sheet show certain differences. During maximum extension there was a chance for the development of the following forms: (1) kames and kame belts at the edge of the ice; (2) fluvial plains and valley trains in virtual contact with the ice at their heads; (3) border plains or overwash plains in virtual contact with the ice at their upper edges; (4) ill-defined patches of stratified drift, coarse or fine, near the ice; (5) subaqueous overwash plains or deltas formed either in the sea or lakes at or near the edge of the ice; (6) lacustrine and marine deposits of other sorts, the material being furnished by waters arising from the ice. The same deposits might be formed during the advance of the ice, but would be subject to destruction by the overriding of the latter. They might be formed during the retreat, but in the latter case the formations dependent upon ice edge would not be so sharply formed. Supraglacial streams are believed to be of only slight importance in this connection, because of their high velocity and the small amount of material upon the surface of the ice. Subglacial streams are considered to be the most probable means of the formation of eskers.

H. F. B.

#### TERRESTRIAL MAGNETISM, OCTOBER.

IN the first article, by Lieutenant-General de Tillo, entitled *Isanomales et Variations Séculaires des Composantes Y et X de la Force Magnétique Horizontale pour l'Époque 1857*, the author concludes his series of charts of 'isanomalous lines' and of 'lines of equal annual secular variation.' As the title implies, the accompanying four colored plates apply to the westerly component (*Y*) and the northerly com-

ponent ( $X$ ) of the earth's magnetic force, and to their secular variations,  $\Delta Y$  and  $\Delta X$ . After obtaining the mean value of  $Y$ , for example, for a given parallel of latitude, he subtracts this from the values at selected points on that parallel. After proceeding thus for various latitudes he joins the places by lines where the residual  $Y$  has the same value, these lines being his 'isanomalous lines.' He finds that the  $X$  isanomalous lines present the same general characteristics as those of  $H$  (horizontal component), the  $Y$  as those of  $D$  (declination), and the  $Z$  (vertical force) as those of  $I$  (inclination). The same applies with regard to the secular variation of the components and elements. There is, furthermore, a strong resemblance between the respective isanomalous lines and lines of equal secular variation.

*On the Distribution and the Secular Variation of Terrestrial Magnetism. No. IV.: On the Component Fields of the Earth's Magnetism.* By L. A. Bauer. This paper is a continuation of the author's researches to localize the centers of disturbance in the earth's permanent magnetic field. He resolves the total field into three components, as follows:

I. A homogeneous magnetization about the rotation axis.

II. A homogeneous magnetization about an equatorial diameter.

III. The residual magnetization, *i. e.*, that which remains after deducting I. and II.

A striking graphical representation of No. III. is given. It is found, among other things, that the residual field and Schuster's diurnal variation field exhibit a strong resemblance.

Dr. Börgen, of Wilhelmshaven, contributes a valuable article in which he develops the most general expression for the coefficients in the formula giving the angular deflection of a magnetic needle produced by a deflecting magnet arbitrarily placed. After discussing the general case he takes up special cases ordinarily met with in practice.

Mr. Baracchi, the director of the Melbourne Observatory, gives an interesting account of 'Magnetic Work in Australia.' It seems unfortunate that no means have been found thus far to reduce and discuss the observations extending over thirty years.

Next follow editorial notes, reviews by Schott, Littlehales, Solander and P. W., and a list of current publications. This number concludes volume I.

#### SOCIETIES AND ACADEMIES.

##### THE SCIENTIFIC ASSOCIATION OF THE JOHNS HOPKINS UNIVERSITY.

THE one hundred and twenty-ninth regular meeting, President Remsen in the chair. The following papers were presented and read:

'Recent Researches on Metallic Carbides and Allied Compounds,' by Edward Renouf.

The recent application of the electric arc as a means of obtaining very high temperatures has stimulated research on metallic compounds formed at high heat and unstable in contact with water, hence not found in nature. We owe knowledge of the carbides or compounds of metals with carbon, principally to Moissan. Most metallic carbides are made by heating oxides with carbon at temperatures varying from 3500° to 5000°. They are metallic substitution products of hydrocarbons, and as a rule yield hydrocarbon and metallic hydroxide in contact with water. Some are acetylides yielding pure acetylene, as is the well-known calcium carbide used for the technical preparation of acetylene. Aluminium and beryllium carbides are methides yielding pure methane. Many other carbides, notably those of uranium and iron yield complex mixtures of saturated and unsaturated, gaseous liquid and solid hydrocarbons. Moissan thinks that natural gas and petroleum are formed by action of water on carbides contained in the earth's crust. Considering the evidence, this is the most acceptable solution of the problem of the formation of petroleum and natural gas yet offered. Metallic nitrides, compounds of metals with nitrogen, are mostly made by contact of nitrogen with metals at high temperatures; some by the action of ammonia on metals at high temperatures, when hydrogen escapes and the metallic nitrides are formed. They are decomposed by water into ammonia and metallic hydroxides, hence must be regarded as substituted ammonias.

Metallic silicides, compounds of metals with silicon, are formed by heating metals with sili-

con, and yield, on treatment with water, metallic hydroxides and silicon hydride. Metallic borides are made in the same way and behave similarly with water, excepting that boron hydride is itself decomposed by water forming boric acid.

The metallic hydrides, or compounds of metals with hydrogen, are but little known. The hydride of lithium has been carefully studied by Guntz, the hydrides of calcium, strontium and barium and of some rarer metals by Winkler. The hydrides are all stable at very high temperatures, but are decomposed violently by water, yielding metallic hydroxides and hydrogen.

Spectrum analysis proves the existence of hydrogen, carbon, and many metals, in the stars and in the atmosphere of the sun, at temperatures too high for water, ammonia and most metal oxides to exist. It is highly probable that the metals exist in the heavenly bodies at the present time and formerly existed on the earth when the earth was hot enough, in combination with the elements mentioned above. A study of the decomposition of these compounds with water and with air, throws light on the chemical changes and rearrangements occurring on the cooling of a world; for example, metallic hydrides cooled to a sufficient temperature in presence of oxygen take fire and burn, forming metallic oxides and water vapor; the oxides form hydroxides with the water. Carbides are broken down by the water into hydroxides and hydrocarbons. The hydrocarbons burn in oxygen to form water and carbonic acid, which last combines with the hydroxides to form water and metallic carbonates. The ammonia necessary for the beginnings of plant life could be furnished by action of water on the nitrides. The formation of silicates and borates would necessarily occur in the same way as that of the carbonates. Thus we can by laboratory study form a clear picture of the genesis of the metallic compounds now existing on the earth.

'A Recently Discovered Property of the Blood Serum in Animals immune from Certain Diseases and its Application to the Diagnosis of these Diseases in Human Beings,' by Dr. Simon Flexner.

A significant advance has just been made in

regard to the diagnosis of typhoid fever. The basis of this advance is the so-called cholera reaction of Pfeiffer which, it may be recalled, was introduced for the purpose of discriminating between the vibrio of Asiatic cholera and certain allied bacterial forms. Pfeiffer found that the blood serum of an animal rendered immune from the cholera germ would, if admixed with a pure culture of this germ and introduced into the peritoneal cavity of a guinea pig, cause a rapid dissolution of the micro-organisms, while no effect was exerted upon other, although closely allied, species. The same reaction can be obtained with various other bacterial forms, such as the diphtheria bacillus, typhoid bacillus, cholera bacillus, etc., provided the serum of animals immune from these organisms be substituted for the cholera serum. Thus it was shown that the action of the immunized sera is specific for a particular kind of bacterial protoplasm. The changes which are induced in animals by exposing them to experimental infection with the bacteria mentioned take place, in a similar manner, in human beings who suffer from the diseases caused by these micro-organisms. In the course of typhoid fever, cholera and diphtheria immunizing substances, before absent, now appear in the blood and other fluids of the body.

It seems very natural to reverse the order of applying the reaction mentioned and, instead of using a specific immunized blood serum to detect a particular kind of bacterium, to employ a specific micro-organism in order to discover the presence of the immunizing substances. Proceeding upon this idea Widal, and after him Grünbaum, suggested that in doubtful cases of typhoid fever the blood of the patient might be utilized for the purposes of diagnosis. The method of making the tests are simple and readily carried out. Widal recommends adding to a bouillon culture of the bacillus typhosus about 1-10th of its volume of the blood serum from the suspicious case. If it is one of typhoid fever the bacteria soon begin to run together, form clumps and gradually sink to the bottom of the test tube in the form of a sediment. A slight modification of this method consists in using a mixture of blood serum and bouillon in the proportions mentioned, which

is inoculated with typhoid bacilli from a pure culture. The growth of the bacilli, instead of taking place in a diffuse manner throughout the fluid, is in the form of clumps, which fall to the bottom of the tube. In the simplest form the reaction may be obtained from a drop of blood taken from the finger tip or lobule of the ear and which has been allowed to dry upon a glass slide. The dried blood is moistened with a drop or two of water in order to cause a solution of the serum, and a small amount of this solution is added to a drop of a living culture of the typhoid bacillus. If this mixture is now observed under the microscope the bacilli are seen to quickly lose their motility, and in a short while (within 30 minutes) to run together to form clumps, or, as these have been called, 'agglutinates.' This reaction has been obtained as early as the third or fourth day of the disease and as late as the ninetieth, and promises to be fairly constant. It may persist for a considerable period—limit unknown—after recovery; for the blood of persons still shows the reaction two years after the disease. As far as we are informed at present the reaction is to be relied upon as diagnostic. It has grown out of the Pfeiffer cholera reaction; but it differs from this in dispensing with an animal for the experiment, and also because in it the bacteria do not proceed to disintegration but merely to agglutination.

The papers presented and read by title were:

'On Singularities of Single Valued and Generally Analytic Functions,' by A. S. Chessin.

'On the Analytic Theory of Circular Functions,' by A. S. Chessin.

Adjourned.

CHAS. LANE POOR,

Secretary.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 256th regular meeting of the Society was held Tuesday evening, January 5, 1897. The program for the evening consisted of a Review of Anthropological Progress during 1896, in ten minute papers.

Dr. Thomas Wilson, in his review of Prehistoric Anthropology during the year 1896, considered: 1. *Pithecanthropus erectus*, in which he noted the decision of this Society, that the

specimens found by Dr. DuBois in the Island of Java were human remains, and that naturalists concurred in this view; that they belonged to the Pliocene age, and the associated fossil vertebrate fauna resembles that of the Siwalik hills of India. Personally he (Dr. Wilson) refused his adhesion to this theory and proposed to await further developments. 2. Prehistoric Man in Egypt. Late explorations and excavations made in Chaldea, by a party from the University of Pennsylvania, pointed to the discovery of written characters, said to date about 5000 B. C., that of Egypt about 1000 years less. He had seen the last will or testament of an Egyptian, from Kahfūn, dated about 2650 B.C. and has a copy of its translation, which could be admitted to probate in our Orphans' Court.

The discoveries by General Pitt-rivers and Prof. H. W. Haynes did much toward establishing the existence of a Palaeolithic age in that country. The latest researches were made by Mr. de Morgan, and prehistoric settlements were found scattered from Cairo to Thebes, a distance of nearly 500 miles, and a collection from these places was exhibited by Dr. Wilson, which indicated human occupancy of the Nile valley by a people in the Neolithic stage of culture and, consequently, much earlier than any of those belonging to any Egyptian stage heretofore known.

Prof. Otis T. Mason then spoke 'On the Mato Grosso, South America, as a Mingling Ground of Stocks,' and called attention to the investigations of Paul Ehrenreich, Carl von den Steinen and Herman Meyer. In the region of the Xingu, Tocantins and Maderia rivers are mingled people speaking the same stock languages, Carib, Arawak, Gès or Tapuya, as when Columbus made his first voyage of discovery, and using implements found among the inhabitants of the head waters of the Amazon in western Brazil and eastern Peru, and also those in use in eastern Brazil; thus were the cultures of the east and west parts, both dissimilar, found associated in the Mato Grosso.

There are two kinds of bows found in South America: the long, black palm-wood bow, of rectangular shape, of the western country; and the broad, wide blade of red mimosa wood, of

eastern Brazil, and monkey bone lashed at an angle, used as harpoon and arrow combined in the west and pointed reed in the east.

In the west, wood-skin or bark boats; in the east, raft of logs or reeds; but in this region the Mato Grosso, both varieties of bows, arrows, rafts and boats were used, showing how the two dissimilar cultures were united in a common locality. Discussed by Messrs. Pierce and Lamb.

Mr. Geo. R. Stetson gave the results of 'Memory Tests of Whites and Blacks,' in which he gave the details of tests made upon white and black school children. In some tests the range of percentage varied quite largely and in others they were remarkably equal between the two classes of subjects. Discussed by Prof. Lester F. Ward.

'Aboriginal Habitations of Maine,' by Mr. F. H. Cushing, was omitted owing to his absence.

Prof. W J McGee spoke upon Zooculture, in which he described the three stages of the relation of birds and animals to man, as individuals and as a community: 1. Toleration. 2. Domestication. 3. Artificialization. Discussed by Messrs. Flint and Stetson.

Dr. J. W. Fewkes read a paper on 'Types of Pueblo Pottery.' He noted the fact that pottery was found in the most ancient ruins and that the art of pottery making was still practiced by modern Pueblo people, but it had degenerated as to texture, finish and adornment.

More care was taken by the ancient potters in the fineness of paste, in the symbolic decoration and general finish. In classifying pottery the classification of Holmes seemed the best. 1st. Coiled ware. 2d. Plain ware. 3d. Painted ware, and to this he would add a 4th, glazed ware.

The principal fact brought out in his studies for 1896 was the collection of material illustrating the extension of Tusyan people southward. The one point he wished to emphasize, relative to the different types of Pueblo pottery, was homogeneity of ancient Pueblo culture. Discussed by Prof. Thos. Wilson.

Dr. J. H. McCormick reviewed the principal events in the field of Folk-Lore for 1896. The

memoirs of the American Folk-Lore Society were by Mrs. Fanny D. Bergen, on 'Current Superstitions,' in which she has collected a great variety of superstitions of English-speaking people in the United States, embracing every phrase of life, from birth to death; and 'Navajo Myths,' by Dr. Washington Matthews. No one is better qualified than this author to tell us the mythology of this tribe, and it constituted the most valuable contribution yet published concerning this interesting people.

The speaker also paid deserved tribute to the memory of Capt. J. G. Bourke, who had died during the summer of 1896, and who was at the time President of the Folk-Lore Society. These two publications, together with Mr. Cushing's paper on 'Outlines of Zuni Creation Myths,' in 13th Annual Report of Bureau of Ethnology, constituted the most important contributions to Folk-Lore during 1896. The work of the Society was discussed at some length, and the establishment of a Local Branch at Cincinnati, under the presidency of Prof. Chas. L. Edwards, of the University of Cincinnati, as a result of a visit by the speaker to that city, and the excellent work done by the Local Branch in Baltimore, were noted.

The 8th annual meeting, in New York, was then considered in some detail.

'Developments of Education during the year' was the subject of Mr. J. H. Blodgett, and it was noted that expansion and modification of ideas rather than distinct steps or discoveries had been the rule.

The most notable events were the continued agitation of the art and manual training studies in schools, child study and its bearing on psychology, and the teaching of religion in schools. The latter had been discussed more in other countries than our own. Considerable attention had been given to the methods of teaching and the principles which underlie them.

The 257th regular meeting of the Anthropological Society was held Tuesday evening, January 19, 1897.

This being the annual meeting, the reports of the Secretary, Secretary of the Board of Managers, Treasurer and Curator were submitted.

The election resulted in the selection of the following officers for 1897: President, Dr. Frank Baker; 1st Vice-President, Prof. W. J. McGee (re-elected); 2d Vice-President, Mr. Geo. R. Stetson (re-elected); 3d Vice-President, General Geo. M. Sternberg (re-elected); 4th Vice-President, Dr. Cyrus Adler; General Secretary, Dr. J. H. McCormick (re-elected); Secretary to Board, Mr. Weston Flint (re-elected); Treasurer, Mr. P. B. Pierce (re-elected); Curator, Mr. F. W. Hodge (re-elected); Councils (additional members of): Mr. J. H. Blodgett, Mr. J. W. Fewkes, Dr. Geo. M. Kober, Mr. J. D. McGuire, Mr. J. O. Wilson, Dr. Thomas Wilson.

No papers were read.

J. H. MCCORMICK, M. D.,  
*Secretary.*

SECTION OF THE AMERICAN CHEMICAL SOCIETY,  
92D MEETING, JANUARY 14.

AT this the 13th annual meeting of the Society the following officers were elected for the ensuing year; viz:

President, W. D. Bigelow; Vice-Presidents, H. N. Stokes, Peter Fireman; Secretary, V. K. Chesnut; Treasurer, W. P. Cutter; Executive Committee, the foregoing officers and E. A. de Schweinitz, Chas. E. Monroe, W. H. Krug, Wirt Tassin.

Dr. E. A. de Schweinitz, the retiring President, announced the date of his annual address as February 25th, the subject to be 'The War with the Microbe.'

V. K. CHESNUT,  
*Secretary.*

BOSTON SOCIETY OF NATURAL HISTORY.

A GENERAL meeting was held December 16, 1896, twenty-eight persons present.

Prof. F. W. Putnam prefaced his statement concerning some recent work at Trenton, N. J., bearing upon the early presence of man in the Delaware Valley, with a detailed description of the discovery, in 1879, in the undisturbed gravel, of a stone implement near a boulder. Explorations in the Trenton gravels have been carried on systematically since 1891, by Mr. Ernest Volk, under the direction of Prof. Putnam; and a section at the place recently examined shows three distinct upper layers, namely:

(1) black soil, (2) glacial sand, and (3) white glacial sand. Implements of chert, jasper, and quartz, as well as of argillite and of pottery, characterize the black soil, while chipped argillite, with occasionally a quartzite, are found in the glacial sand. All but four specimens thus far found in the glacial sand are of chipped argillite; there are no jaspers or cherts. The distinctive implements and the layers are sharply correlated, and the accuracy of Abbott's early work is emphasized by the later work of Volk.

Prof. G. Frederick Wright discussed the extent of preglacial erosion in the United States and its bearing on the question of the length and date of the Glacial period. The new evidence as to the age of the deposit of the Trenton gravels confirms the results first announced by Lewis and Wright. The Philadelphia brick clays are older than the Trenton clays, and the work of E. H. Williams proves that the rock erosion was earlier than the Philadelphia brick clays. Prof. Wright reviewed the work of Salisbury in New Jersey, of White in the deposits of the Monongahela River, the evidence obtained in Iowa, and Claypole's discovery in the glacial till of Ohio, and showed that the necessary data for more accurate conclusions were accumulating.

Prof. Putnam spoke of the rude knife found at Steubenville as the most highly finished of all the specimens yet found, and said that being *chipped* was favorable to its greater antiquity than if it had been *flaked*. The patina on the implement is very decided.

SAMUEL HENSHAW,  
*Secretary.*

THE GEOLOGICAL CLUB OF THE UNIVERSITY OF MINNESOTA.

At the weekly meeting, held Saturday, January 16th, a paper was read by Arthur H. Elftman, on the use of certain terms prominent in petrology. Incidentally the terms granitic and pegmatitic were noted. The growth of the terms ophitic and poikilitic in geologic literature was then outlined and an attempt made to define them more rigidly than had hitherto been done by petrologists.

CHARLES P. BERKEY,  
*Secretary.*

